Teacher's Manual for

NTER COMES AND GOES

The HOW AND WHY Science Books

Frasley

A TEACHER'S MANUAL
AND SCIENCE HANDBOOK
to accompany

WINTER COMES AND GOES
BOOK II

of the

HOW AND WHY SCIENCE
SERIES

including also

A KEY TO THE COMPANION BOOK

Prepared by
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THE HOW AND WHY SCIENCE BOOKS

WE SEE (PRE-PRIMER)
SUNSHINE AND RAIN (PRIMER)
THROUGH THE YEAR (GRADE 1)
WINTER COMES AND GOES (GRADE 2)
THE SEASONS PASS (GRADE 3)
THE HOW AND WHY CLUB (GRADE 4)
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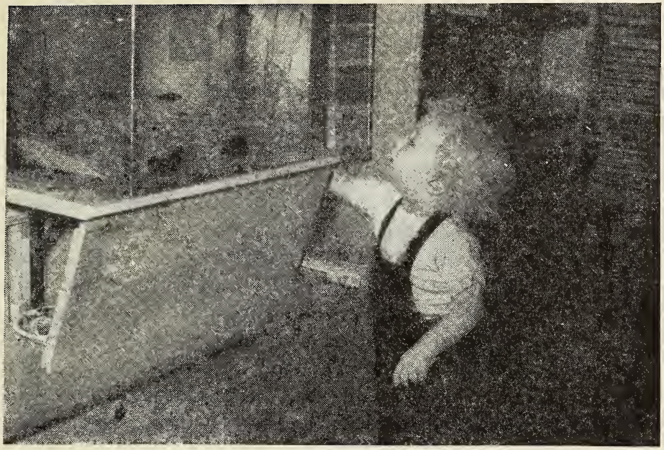


"All knowledge begins in wonder."

ELEMENTARY SCIENCE

THE PHILOSOPHY OF SCIENCE TEACHING

Someone has said, "All knowledge begins in wonder." A child entering school for the first time brings with him spontaneous enthusiasm and interest in the world about him which manifest themselves in an eagerness to relate his experiences. He is full of questions about the caterpillars, frogs, turtles, and other live things that he finds as he plays. He is curious about the weather, the heavenly bodies, and other physical phenomena of his environment. He asks how and why the mechanical devices of his everyday experiences work.

Too often this natural curiosity of the little child is lost instead of being developed during the first few years of school life, because teachers and parents feel their inadequacy to meet the situation. The knowledge required to answer all these questions is so great as to discourage the average adult. When children are curious, they have no respect for the lines of subject matter. One question may fall in the field of biology; the next in physics or chemistry. To

answer all questions completely might well require more knowledge than even a specialist would possess.

However, to teach science to children it is not necessary to be able to answer all their questions. The alert teacher with abundant enthusiasm and curiosity can help them find the answers to many of their own questions. Nowhere will her efforts bring more satisfying results than in the teaching of science.

The philosophy of science teaching differs very little from that of any other subject. It is the subject matter which makes the handling of it more difficult, because teachers are not generally trained for science teaching. The teacher must take into account those things in the child's experience which lie in the field of science. There are many experiences common to children everywhere that may become the foundations of our science work. From these common paths teachers may diverge with the interests of individuals and the groups, and adapt the teaching to the local community or section of the country.

We live in a world that is changing so rapidly that what is grist for the science mill today may become a waste product tomorrow. One day a Byrd explores Antarctica; a Beebe explores the depths of the ocean; or a Piccard penetrates the stratosphere. At such times even first-graders may discuss the stratosphere but to put the stratosphere into a first-grade book, in the light of our present knowledge, would be questionable.

Again, the children we teach are affected by varied environments. Those of the western plains have a whole set of animal concepts not possessed by children of the Atlantic coast. Children in a mining town, children from the country, children from a metropolis—all have experiences which give them different ideas. But through all these experiences the teachers may teach the same scientific principles. For example, hibernation of animals may be taught to a western child by a study of snakes; to a child in the lake region by a study of frogs; to a child somewhere else by the study of clams, crayfish, or some insect.

In science, the teacher needs to remember individual differences. Some children respond more freely to experiences with plants, some to animals, some to physical science. By encouraging children to express themselves freely in the classroom, and to experi-

ment for themselves with the materials found in the science room, the teacher can discover these differences and make effective uses of them.

Above all, to be a successful teacher of science, one must be enthusiastic about the subject, enjoy working with children, and understand the way they think. She must be scientific in her own attitudes and be able to use the problem-solving method of teaching. She does not have to be a specialist in science nor be afraid that she won't know all the answers. She probably won't be able to answer all the questions which the children ask, but even if she can, to do so would spoil the fun for the children. She need not hesitate to say, "I don't know," providing she continues, "but we'll find out together." Science teaching can be a shared experience of teacher and children that has great possibilities for both.

OBJECTIVES FOR TEACHING SCIENCE TO CHILDREN

Science for the grades should not be regarded as a mere accumulation of facts but as a series of experiences with the science materials that are a part of every child's daily life. These experiences stimulate the curiosity of children and if used properly should lead to behavior changes in the children. To accomplish desirable outcomes the teacher should understand the reasons why anyone studies science. These reasons may be called objectives. Scientists differ in the way they state these major objectives, but they agree on their content. Briefly stated, these objectives of elementary science are:

1. To develop an intelligent appreciation of the natural and physical world.
2. To develop scientific attitudes.
3. To help the child acquire the scientific method of problem solving.
4. To help the child acquire useful knowledge of scientific principles.

By an intelligent interest and appreciation of the world in which he lives, a child is made aware of real beauty that goes deeper than

the mere appeal to sense. Appreciation grows as knowledge is gained. The person who gets a satisfaction from the color and form of a beautiful butterfly should enjoy it more after seeing it go through its transformation from pupa to adult. The child who, looking intently at a butterfly's chrysalis, exclaimed, "Oh, I can see the wings through the chrysalis skin!" was experiencing appreciation. Children should get a thrill out of their science experiences which will make their lives richer and more enjoyable.

Appreciation should lead to the conservation of wild life. The biological principles of the struggle for existence and survival of the fittest make for a balance in nature, unless it is upset by man. Through experiences with material such as that used in "Insects in the Garden," "Birds in the Orchard," and "Life in the Pond," children may be led to see the relationships of plants and animals. They learn which ones are harmful, and what to do about them, as well as which ones are helpful to man.

The second objective, that concerning scientific attitudes, should run through all science teaching. The child who has these scientific attitudes:

(*a*) Will have a conviction of basic cause-and-effect relation which will make it impossible for him to believe in superstition or unexplained mysteries.
(*b*) Will have a sensitive curiosity which will lead to making accurate observations, collecting data, and searching for adequate explanations.
(*c*) Will have the habit of delayed response, preventing him from making snap judgments or jumping to conclusions.
(*d*) Will weigh evidence carefully to find out if it is sound, pertinent, and adequate.
(*e*) Will have respect for another's point of view, being willing to change his point of view in the face of new evidence.

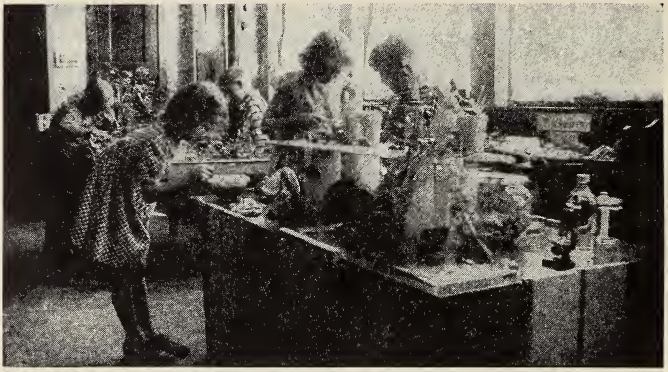
These may sound formidable to the teacher who has had little training in science. She may recognize them as desirable outcomes, yet not have the slightest idea of how to go about teaching them. She need not be frightened, however, because the techniques by which she helps children develop scientific attitudes are

very similar to those she uses to develop social attitudes. The first step is to be able to recognize a *lack* of the attitudes.

For example, a child who says, "My grandmother says the ground hog saw his shadow and he can tell about the weather," does not have the attitude of looking for a cause. The teacher could help him develop the attitude by saying, "That is interesting. I wonder what makes your grandmother think that," or, "I wonder what the ground hog (woodchuck) knows." The child may answer, "If he sees his shadow on ground-hog day, we'll have six weeks of bad weather." Then the teacher may say, "That may be true, but what do the rest of you think about it?" After a brief discussion she may say, "All of you are just giving ideas. Is that the way scientists (or people who study woodchucks) would settle a question?" The children may suggest watching for woodchucks or discussing the weather on February 2—will the woodchuck see his shadow or not? They may watch the weather for six weeks, recording it and comparing the actual weather with the woodchuck's "prediction." Some child may be bright enough to remark, "It may be cloudy in the fields south of town and the sun may be shining on the north side. The north side couldn't have six weeks of bad weather while the south side is having good weather." The grandmother (who would have resented it had the teacher said, "That idea is not true, Tom,") may become interested in a long-time experiment; but, whether or not there is hope for grandmother, Tom's plastic mind has been affected by six weeks of observing and checking.

Later when Dick insists that horsehairs turn into snakes, Tom will be eager to bring rain water and a horsehair to find out if Dick is right. Bit by bit, these experiences will straighten out Tom's thinking until one day he will say, "I don't believe in superstitions. One day when we were out driving, a black cat ran across the road. Later we had engine trouble, but the trouble was caused because a part had worn out."

Not only is this attitude taught by correcting existing superstitions and misconceptions, but it impels children to look for the causes of all natural phenomena. Numerous opportunities arise every day to develop it. For example, in trying to solve the problem of why food spoils, the teacher may ask, "Where does your



Independent investigations.

mother put food that she wants to keep?" Through discussion someone may say, "Temperature will affect food. When food gets hot, it spoils." In problem solving there are many opportunities to teach scientific attitudes.

The ability to interpret natural phenomena correctly does away with unreasoning fears. The child who understands the cause of thunder, and has demonstrated it in a small way by clapping his hands, is not so likely to be afraid of the noise. Knowing that animals are not likely to sting or bite except in self-defense, he is less susceptible to the fear carried by many people into adult life. The person who has studied about meteors and northern lights doesn't assign mysterious reasons or results to these natural phenomena. The child's understanding of the cause and prevention of disease helps keep him from carelessly exposing himself and others, as in the case of colds. He learns that everything has a cause; that disasters don't just happen, nor, as was once believed, are they visited upon us as punishment.

Curiosity concerning their environment is natural to children, though some have more of it than others. But sensitive curiosity may have to be taught. Children ask many questions to which they really don't expect an answer, nor care for one. Sensitive

curiosity is demonstrated by a perseverance on the part of the child in asking a question, or in independent investigation on his own initiative. Children should be given opportunities to tell of things they observe that stimulate their interest and curiosity. If learning is dependent upon desire to know, then curiosity is a valuable attitude to develop. Some children have it to such a degree that no amount of squelching on the part of adults will stop their investigations. They learn in spite of their teachers. Other timid ones stop asking when they get no satisfactory explanation. The child who persisted in saying, "I *want* to *know* what makes the bubbles in cake," after the teacher had told her it was too hard for her to understand, had unquenchable curiosity.

The ability to make careful, accurate observations and the ability to collect data are outcomes of the attitude of sensitive curiosity. Some teaching techniques which help in the teaching of this attitude are:

(*a*) Making use of the children's suggestions of ways to collect data—for example, when Mary wonders what will happen if a prism is held in a cloud of dust while a sunbeam is striking it, let Mary try it, using chalk dust.

(*b*) Insisting upon accurate descriptions when a child reports having seen something—for example, when a boy describing an insect the size of a gnat, tells of a yellow stripe around its body, the teacher may say, "Just a minute. How could you see the yellow stripe on an insect no larger than a gnat? Tell just what you saw. If you didn't see the color, don't tell about it."

(*c*) Setting an example of collecting data by asking questions about many points which the children have not mentioned in their descriptions.

(*d*) Insisting upon experimentation or demonstration being directed to the purpose of gaining adequate explanations. Children are likely to become more interested in the working of the apparatus than in the answer to their original question. Then the teacher may say, "Why are we doing this experiment? Is it helping to answer the question? It is an experiment only as long as you are learning. After that it is play."

The attitude of delayed response is developed by insisting on the children's not "jumping to conclusions." The child who says, "I saw a bird. I *think* it was a woodpecker because it was tapping on a tree," or "I *think* the fish died because we didn't put any green stuff in the aquarium like we do at home," or "I'm *not sure,* but I don't think the air does all of the work of holding the plane up," has developed the attitude. The child who says, "I *know* that was a fallen star. There are a lot of them around here," hasn't developed the attitude.

To help develop the attitude of delayed response, the teacher must be on the alert with answers such as:

"We must be careful and not think we have found out something when we really haven't."

"Do you think you should say they are fallen stars? Has anyone proved it?"

"Let's save that question and answer it later. Then we will find out more about it to help us be sure." (And don't forget to do it!)

Having developed the attitudes of basic cause and effect, sensitive curiosity, and delayed response, children are ready for weighing evidence. Children are usually eager to express their ideas without thought as to whether they are pertinent or sound. When the teacher is just starting her science program, she may encourage expression to get things under way. After the ice is broken and the children are no longer inhibited or shy, the teacher has to curb their enthusiasm and direct their thinking.

To do this without breaking their line of reasoning takes skill. The teacher must not be discouraged if her first attempts at developing attitudes result in confusion. She may have to go back to the beginning of the lesson and start over. When this happens, the teacher should take the children into her confidence by smiling and saying, "I guess I got us off on the wrong track. Let's see where we were," or "We're all mixed up. You'll have to help me. What were we trying to find out?" The children will respond to this.

Some ways to help develop this attitude of weighing evidence are to give suggestions like:

"Let's remember not to take too much time with details that don't really have anything to do with our problem."

"Does your question have anything to do with electricity? Have you thought it through?"

"Do you think that we have enough information to answer the question?"

"Should we decide before we know what a scientist has to say about that?"

"Let's keep our minds on one track."

By consulting an authority, the teacher should check often on the accuracy and soundness of the experiments being done. The children should check with their science text. They should never draw conclusions from one experiment.

A child who has developed this attitude will say things like this: "I think the tooth comes from the upper jaw by the way it curves. If you'll look at a dog's teeth, you'll notice that the upper teeth curve down over the lower teeth. It's hard to tell whether it's the upper tooth of a big bear or the lower tooth of a small bear," or "We haven't read it carefully enough. He forgot to use a marker so I don't think it would be right."

Willingness to change one's opinion in the face of new evidence is the most advanced attitude of all. The person who has it is tolerant, without prejudice and bigotry. If all the children in the world could really be taught this attitude so that it would function, wars would cease. Science has no monopoly on this attitude, but it offers an excellent opportunity for its natural development. In social studies areas, emotions are more likely to be involved. In solving science problems, children can be more objective. The teacher may say:

"There is a sentence on that page that isn't exactly scientific. Scientists have found out more about it since the book was published."

"When one has the floor, let's remember that others want to talk also, and not take too much time."

"Don't laugh. I'm not surprised that he's mixed up. Grown folks get mixed up, too."

"Do we laugh at people who have ideas?"

"Let John have his chance. Let's listen to what he has to say."
"I think he has an idea, but it just isn't very clear."
"Evidently there are three people who do not agree."
"Jane listened to you; now it is her turn."

Allow every child an opportunity to tell one thing he has observed or learned from an experiment. Give careful consideration to every child's serious question or attempt to explain something. If the teacher respects children as individuals, respects the importance of their problems, and is willing to change her own mind when she sees that she is wrong, it will help in teaching this attitude.

The child who has this attitude will say, "I don't quite agree with her because I think there is a change in the temperature of the land," or "I thought the candle wick burned, but now I know that it is the gas that burns."

Children often have pretty definite ideas about their experiences and are not willing to change those ideas. For example, many people use widely advertised products in their homes without investigating their true value. One science group made a study of some of these products and discovered that the advertising was misleading. The children in the group were learning to evaluate and test statements in the light of evidence.

Willingness to change opinion, to search for the whole truth, and to base judgment on fact are all closely related and may be developed together. They may all result from a comparison of experimental data or accurate observations.

A child may have formed some incorrect idea that he has heard or read in a book. For example, a child insisted that "beavers carry mud on their tails" because he had read it in a children's storybook. The other children challenged his statement. The teacher asked how they could know whether or not the statement was correct. The children said to ask a scientist or look it up in several books written by scientists who had studied beavers. When this was done, the child who had made the statement saw that his idea was wrong. He also realized that he could not believe everything he read.

Many elementary teachers have themselves not had the advantage of science training and do not know how to teach by the problem-solving method. Although it is not unique to the field of science, the average elementary teacher may not have learned the techniques necessary to help children learn it and use it. Even if teachers have used problem solving in teaching social studies or arithmetic, unfamiliarity with the science fields may make them hesitate to apply it in that area. Yet science problems are such a natural part of every child's world that the questions he asks are the easiest approach to the development of these particular skills and habits. Since educators agree pretty uniformly that our major objectives lie in the areas of appreciations, attitudes, skills, and habits rather than in subject matter as such, the training of children in the problem-solving method seems very important.

The first thing that a teacher must do before starting to help children learn problem solving is to be able to recognize good problem situations and good problems. Among the questions that children ask are many that are of passing interest and may be answered quickly and easily. But often some of these questions offer opportunities for real problem solving.

For example, a group of first-graders, during their science meeting were reporting their observations of natural happenings. Some of the questions about an icicle that one child showed were:

1. Can you see through that ice?
2. Why is the ice frozen around the stick?
3. Would it freeze again if we put it out today? (The icicle was melting.)
4. How was the icicle made?

The teacher recognized number four as a good problem to help the children start developing some skills, so she used it. The other questions were used in developing the problem.

Some of the things to keep in mind when selecting a problem from children's questions are:

1. Is it suitable for the age level of the child who is trying to solve it?

2. Is it worth spending time on?
3. Are the materials available with which to solve it?
4. Does it offer opportunities for many child activities?
5. Are the children interested in it?
6. Can it be solved within the interest span of the group?
7. Does it contain the elements that make it a real problem to the children?

To illustrate these criteria let us test the problem, "How was that icicle made?"

With a group of children who had had no previous experiences with ice, the problem might have been too difficult. To know this a teacher needs to analyze the problem for the concepts necessary to its understanding. Some of these concepts in this case are:

1. Ice is frozen water.
2. Water freezes out of doors in winter.
3. Heat melts ice.
4. Sunlight gives heat.
5. Snow is frozen water.

The first grade which asked the question about the icicles had developed these concepts in the kindergarten, so this problem was suitable for their group. The problem might have been just as suitable for a fifth or sixth grade which had not had the science experiences of this first grade.

Testing the problem by the second criterion, "Is it worth spending the time on it?" one might say that it isn't very important to know how icicles are formed. Certainly many adults are leading happy, useful lives without the knowledge. We can't justify the value of the problem by the knowledge objective.

From the standpoint of appreciation, icicles are beautiful. That is one reason they attract children. Icicles are also interesting and arouse curiosity. Curiosity, if properly directed, leads to the scientific attitude of sensitive curiosity. Besides these values, the fact that the children are trying to find an answer to their own question makes it an ideal way to develop problem-solving skills.

The third criterion, "Are there materials available with which to solve it?" is satisfied, since in winter we have temperatures for simple experiments with freezing. The fourth criterion, "Does it

offer opportunities for child activities?" is met in that all of the experiments, demonstrations, and observations needed for solution are easily done by six-year-olds. It satisfies number five, "Are the children interested in it?" because the children initiated the problem.

Criterion number six, "Can it be solved within the interest span of the group?" is satisfied at whatever age level we are solving the problem. In the first grade which raised this problem the interest span was rather short. The group met with the science teacher only once a week for a twenty-minute period. Yet for two or three weeks the children kept bringing icicles of different sizes and shapes to the science room, commenting upon them in such a way as to demonstrate an understanding and an appreciation of their formation. Of course their understanding was not as complete as that an older group would have, but as far as it went it was correct.

To check with criterion number seven, "Does it contain the elements of a real problem?" we must analyze what we mean by the elements of a good problem. Why is "How was that icicle made?" a good problem while "Can you see through the ice?" isn't so good?

In the first place, a problem must present an obstacle in thinking. "Can you see through the ice?" presents very little difficulty because to answer it the child merely holds the ice up and tries to look through it. There is no need for the problem-solving technique. The other question cannot be answered so readily. Unless the children have already met the question before and had it answered, they must discuss it and give possible answers based on their previous experiences. Then they must test these possible answers in various ways, finally drawing conclusions from the results of their data. True, this will be done very simply in the first grade, but by repeated learning situations of this kind even six-year-olds begin to develop these skills and habits.

Elementary teachers often say, "It is all very well for a science teacher to talk about these methods of teaching science to children, but theory and practice are two different things. *We* have to teach the children." Elementary teachers are justified in this criticism. Too often college teachers have a tendency to deal with

ideas and theory, neglecting contact with practical teaching situations.

For that reason let us examine several actual problem-solving lessons as taught at different grade levels, for the teaching skills needed to teach them.

The first one was taught in a first grade, and used only the materials of the environment. The problem was child-initiated when there was a hard rain and the children found earthworms on the sidewalk.

PROBLEM: Why do earthworms come out of the ground when it rains?

ANALYSIS:

Teacher's questions—

1. Where do earthworms usually live?
2. What must live things have in order to live?
3. What ideas do you have about why you found the earthworms on the sidewalks?

Hypotheses or possible answers given by the children were—

1. Maybe the earthworms want water.
2. Maybe the earthworms come out to breathe.
3. Maybe there is too much water in the ground so the earthworms will drown if they don't come out.
4. Maybe the earthworms' homes are ruined by rain and they have to come out.

SOLUTION:

A. Gathering data:

The teacher asked the children to suggest ways of finding out whether or not their answers were correct. As a result of the discussion, the children did these activities.

1. They put some earthworms on top of some soil and watched them burrow into the ground.
2. They examined some soil with a hand lens to see the spaces between the soil particles.

3. They put soil in water and saw bubbles of air escaping.
4. They poured water into a glass jar of soil until all of the air had bubbled out of the soil and water was standing on the soil.
5. They found earthworms in puddles where they had been unable to find drier soil.
6. They put water into the jar containing the earthworms and watched the earthworms.
7. The teacher drew an enlarged diagram of an earthworm's burrow to illustrate the relative sizes of worms to soil particles and air spaces.

B. Results:

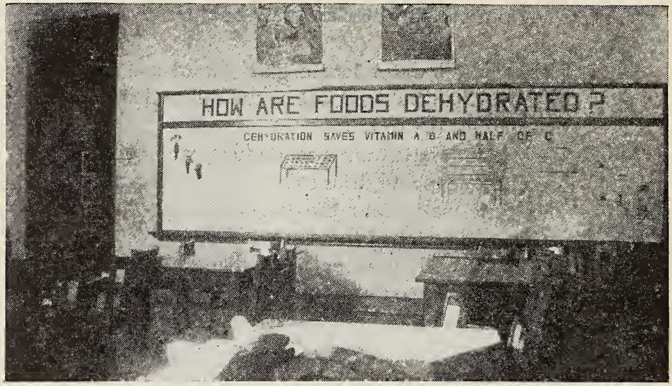
1. The earthworms burrowed into the moist soil, head end first.
2. The soil particles looked like tiny rocks.
3. & 4. Bubbles of air were plainly seen.
5. The earthworms in the puddles were dead.
6. As the water filled up the spaces between soil particles and air came out, the earthworms came to the surface and crawled out of the jar.

CONCLUSIONS:

When the earthworm's hole was full of water, it couldn't get air so it crawled out. When the ground was dry it would crawl back into its hole. If the earthworm couldn't get back into its hole and the ground was covered with water, it died.

This was a very simple problem but it offered all of the elements of real problem solving on a six-year-old level. The information could be gathered by the children themselves and was concrete enough for them to draw correct conclusions. They could check their results with those of the children in the story of earthworms in THROUGH THE YEAR.

This problem-solving lesson has illustrated the utilization by the teacher of a child's question for accomplishing her own objectives. We cannot always wait for questions to arise naturally to



As children grow older, their problems enlarge.

initiate science problems. The teacher must know the problems that are suitable for the group she is teaching, and at times she must create situations to motivate the setting up of these problems. Once initiated, the science program will usually keep going under its own power. New problems will grow out of those in the process of solution. The teacher and children will find themselves with more problems than they can possibly solve in the time they have. These problems should be recorded and used to start another year's work, or handled through individual or group reports.

As children grow older and develop more skill in handling problems, their problems will enlarge. They may break down these larger problems into minor problems to be solved. The time taken for solution will increase and the children may be taught to recognize the steps in their thinking. They may begin to record their data. This will be a group activity at first, with the teacher writing on the board the simple statements made by the children.

For example, a second grade in trying to answer their questions of "How did this piece of salt get on the shore of Salt Lake?" did some simple activities to clarify the concepts of *solution* and *evaporation.* At the end of one activity the teacher wrote the following results on the board as the children gave them to her.

1. Salt dissolves in water.

2. We couldn't see the salt in the water.
3. When the water evaporated we saw the salt again.

These children were able to check the results of this activity by reading in their second grade science text, WINTER COMES AND GOES.

Third-graders have developed enough reading skill to be able to supplement their own observations and experimentation by reading. They are also able to begin writing a few sentences as a record of the conclusions to their problems. The teacher should handle this just as she does the written language work the children do, being sure that the conclusions recorded are correct.

Analyzing problem solving for some of the difficulties that arise in teaching it, let us look at a rather simple lesson, "Why does a candle burn?" What are the concepts and skills a child needs for setting up the hypothesis and solving it? Some of the concepts needed are:

1. A candle is made of wax.
2. Wax is a solid.
3. Wax melts when heated.
4. Solids may be changed to liquids by heating.
5. Liquids may be changed to gases by further heating.
6. There is something in all fuels that burns.

Some of the skills the child will need are:

1. Ability to handle the simple apparatus needed.
2. Ability to observe accurately.
3. Ability to work carefully.
4. Ability to draw correct conclusions from accurately observed results.
5. Reading and language skills necessary for checking his results and recording them.

The teacher has to anticipate all of these needs and plan carefully. She must realize the safety measures to be provided in any experiment involving fire. She must guard against unscientific attitudes, such as drawing conclusions with insufficient evidence. She must be alert at every step in the procedure for opportunities to develop scientific attitudes and good habits of thinking.

Perhaps this all seems like a very complicated and difficult task to the teachers who have not used the problem-solving method. It would be if you started out trying to teach it all at once. If you begin slowly, one step at a time, you will find the children co-operating eagerly. The satisfaction gained by feeling that you are teaching habits of thinking that the children will be using long after they've forgotten some of the bits of information makes the effort worth while. A child's spontaneous comment at the end of the solution of the problem, "Why do teeth decay?" illustrates this point. It had taken some time to finish and the teacher was feeling a bit discouraged at the seeming waste of time. The child wrote his last sentence of the conclusion with an audible sigh of satisfaction and remarked, "Boy! I call that finishing a real job. That's really getting something when you find out yourself instead of just reading." When the children themselves realize the value of their learning, it must be worth while.

These values, in part, are:

1. The ability to recognize and formulate problems.
2. The ability to set up reasonable hypotheses.
3. The ability to gather data by means of suitable activities for testing the hypotheses.
4. The ability to record accurate results.
5. The ability to generalize from results, draw correct conclusions, and check with an authority.
6. The ability to apply the conclusions to similar problems.

In addition to these skills and habits, scientific attitudes and knowledge are gained in the solution of pertinent problems.

A science room.

SCIENCE ACTIVITIES COMMON TO ALL GRADES

THE SCIENCE ROOM

The problem of how to care for materials and specimens is a real one for the grade teacher. If there is a separate science room, these may be cared for in the cabinets, display cases, and closets provided for them. If not, some space must be allotted in the regular classroom. They need not take up much room, for the apparatus needed for teaching elementary science is simple. A few glass jars, dishes and bottles, a few tin cans, some pieces of wire netting, cheesecloth and some candles may be the only things needed. An electric plate, alcohol lamp, or some other source of heat is necessary for some of the experiments suggested. But if these are not available, other common experiences may be substituted. In some schools it is against the rules to have fire in the classroom. Unless an electric plate can be obtained, the radiator is the only source of heat. There is such a variety of home-made equipment and substitutes for expensive apparatus that the ingenious teacher can always find some material for her activities. Running water is a great convenience. The children should have

Shelves provide places for permanent collections.

a share in assembling needed apparatus but the teacher must be responsible for seeing that it is ready when it is needed.

The regular classroom may be made more attractive with a few well-kept aquaria, terraria, and growing plants. Suggestions for maintaining these in good condition are given in other parts of this Manual. A science table will provide for the specimens of rocks, insects, birds' nests, and other things the children collect and bring to school. It should be well kept and cleared at intervals. As a child brings in his contribution it can be discussed, named, and put on the table with a small sign telling what it is and the name of the donor. A few cases of shelves will provide a place for more permanent collections.

A table with a few interesting things that the teacher provides helps to stimulate science work. These specimens should have labels telling enough about them to arouse curiosity and a desire to know more. For example, an oyster shell may be labeled, "This is the outside of an animal. It lived in the sea. It is used for food. You have a relative of this *oyster* in your aquarium. Do you know what it is?" The relative is a snail or perhaps a clam.

In some schools, glass display cases in the hall offer a place where science material may be exhibited. These exhibits should be changed frequently. For example, a group of children may

be studying rocks. They may put some of their best specimens, with neat labels, in the hall case. Other children of the school will enjoy this display and learn from it.

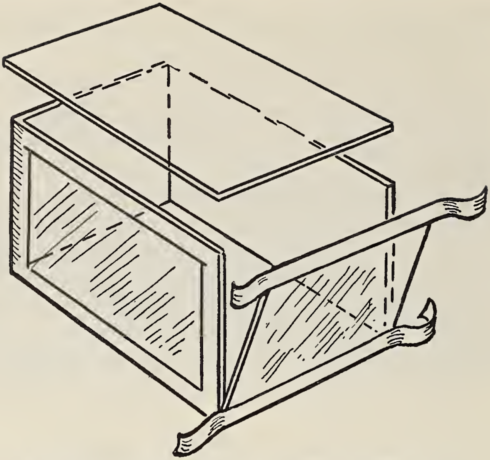
If the teacher wishes to buy equipment she may order it from any one of several scientific supply companies. Many of the things she needs such as dry cells, wire, and magnets may be bought at local ten-cent stores.

Bulletin boards are an important addition to the science room. They may be used by the children for the clippings and pictures they bring to class. The teacher may use them to motivate units or lessons, or to display summarizing activities at the end of a unit. They may be used for pictures of birds, wild flowers, or other aids to identification. There are many charts, such as the Audubon Bird Charts, which may be used for the same purpose. Bookshelves for reference books and magazines and a case for maps and charts should be provided.

Science material, whether it is alive, or is physical apparatus, must be kept in good condition. Nothing is so likely to kill the interest in science as dirty glassware standing around the room, cloudy aquariums, boxes of dead caterpillars, or unhealthy animals. There is much plain housekeeping in the science room, but all of it can be used to help teach children careful habits, particularly if the children are given the responsibility of helping to do this housekeeping.

HOW TO MAKE A TERRARIUM

A simple terrarium has so many uses that it is well to know how to make one. First, it is necessary to have a container. A glass jar of any kind will do, but one with straight sides is better than a round one. A glass box may be easily made from six pieces of window glass cut to the desired size. These may be fastened together with one-inch adhesive tape or black *passe partout* tape. Rub the tape until it sticks firmly to the glass. The lid may be fastened so that it is hinged, or merely laid across the top. All edges should be bound with tape to prevent cut fingers. A further precaution is to have the edges of the glass beveled at the time it is being cut.



A terrarium made from glass and adhesive tape.

A wooden base instead of a glass one may be used for the box. If wood is used, it should be so cut that at least one inch will project from around the glass at the bottom. The board may be treated with melted paraffin to make it resistant to water. A half-inch furrow should be sawed in the wooden base, the dimensions of the glass, and made wide enough to take the glass. The glass sides can be more firmly secured in the furrow by means of aquarium cement or putty. Adhesive tape may be put around the top to make smooth edges.

Having a container, start making the terrarium by putting a layer of gravel in the bottom, to provide drainage. Small pieces of charcoal will help keep it sweet. On top of the gravel put soil of the kind found where the plants grow which are to be used in the terrarium. For example, moss and ferns come from the woods. Use woods soil, or leaf mold, for a woods terrarium. Use garden loam for a garden terrarium. Use sand for a desert terrarium.

In the soil plant the moss, ferns, or other plants you wish to use. If you are going to put animals which eat plants into the terrarium, some of these food plants should be planted. For example, if

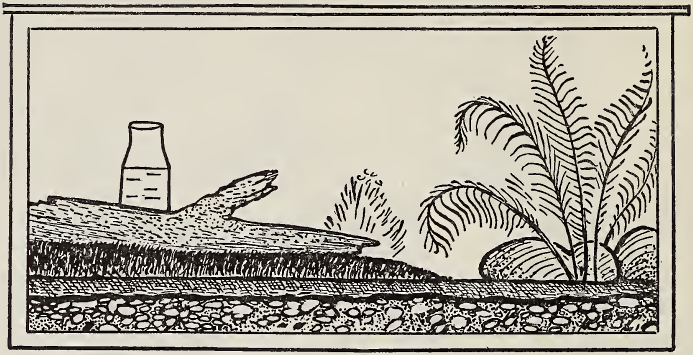
Making a terrarium for a garter snake.

making a home for grasshoppers, plant corn or oats and let it sprout before putting in the insects. For toads, use garden soil, a dish of water sunk into it, with perhaps some stones and a little grass. The toad will bury itself in the soil. Salamanders like moist moss and pieces of decaying wood under which to bury themselves. Lizards and horned toads will bury themselves in the sand of a desert terrarium.

The terrarium should be kept out of strong sunlight and in a place that is not too warm. It should be sprinkled with water when first made, if it has plants in it. After that it should be sprinkled only when the cover gets dry on the underside. Water should be kept in a dish if there are animals in the terrarium. Snakes go into water, and a tall container like a pint milk bottle or pickle jar of water will make them comfortable. A low dish is better for turtles and toads. This can be placed in one end of the

terrarium and stones and soil built up around it to the level of the top of the dish.

A single terrarium should not contain a large variety of animals. Since boxes of glass and adhesive tape are practical and inexpensive, it is better to have several, each one containing a different kind of animal.



A woods terrarium.

The food of frogs and toads in the wild state consists of insects, worms, caterpillars, snails, and slugs. They also eat flies, mosquitoes, and gnats. These can be easily provided, but they should always be alive. Frogs and toads will not touch dead worms or insects. They will starve in a terrarium if they have no live food to eat. A fly trap can be made and once a day the flies released from the trap into the terrarium. When there are insects out of doors, they may be caught by sweeping the grass with an insect net. In winter when flies are scarce, meal worms and meal bugs, which can be cultivated in bran flour, can be substituted.

Newts and salamanders can be fed on bits of raw meat, fish, oysters, scrambled eggs, worms, or insects. Land turtles are plant-eaters, using tender plants and berries for food. Water turtles are meat-eaters, using earthworms, insects, crayfish, and small fish. Mud turtles do not eat unless they are under water. Horned toads eat living insects. Garter snakes eat earthworms, insects, frogs,

salamanders, and toads. Snails are vegetarians; lettuce is a good food for them.

Care should be taken that an excess of uneaten food does not remain in a terrarium. Terrariums should be kept clean so that the captive animals may live in healthful conditions.

HOW TO MAKE AN AQUARIUM

Almost any container that holds water may be used for an aquarium, but a straight-sided one is best. The globe-shaped ones afford too little water surface for the absorption of air and they distort the shape of objects inside the aquarium.

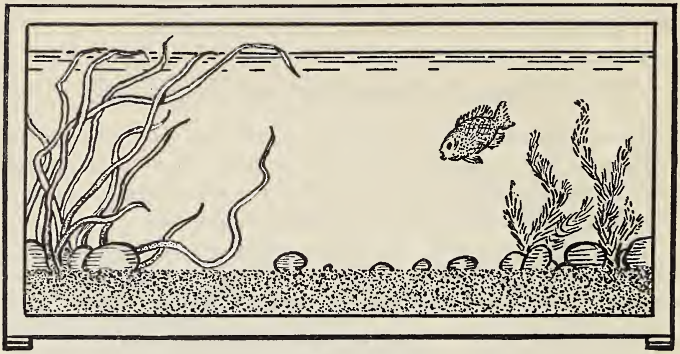
The container must be very clean, and the sand must be thoroughly washed. Sand may be washed by running a stream of water into the pan of sand until the water runs out clean. If the sand is then baked in an oven, any bacteria or mold spores will be killed.

Enough sand should be put into the bottom of the aquarium to insure a good root-hold for the plants. Elodea, eelgrass, and water milfoil are all good aquarium plants and are common in most of our fresh-water lakes and streams. These are satisfactory for summer aquariums but they do not always survive the winter. There are many inexpensive tropical water plants which can be used. Such varieties as Valisneria, Cobomba, Myophilum, and Sagittarium are commonly obtainable. It is believed that Valisneria is the best oxygenating plant. This is a grasslike plant which grows very quickly. Duckweed is a small leaflife plant that is often found floating on ponds. It is attractive in an aquarium, though it doesn't help to supply much oxygen.

The plants should be planted in the sand, then anchored with stones. Water can be poured into the aquarium without disturbing the plants by putting a piece of paper on the sand and pouring the water on the paper, or a dish may be placed on the sand into which the water can be poured.

Clean pond, lake, or rain water is best for an aquarium because it contains minute organisms that may later feed the animals. If tap water must be used, allow it to stand several days before putting it into the aquarium. This allows any lime that might spoil

the sides of the aquarium to be deposited and frees the water from any chlorine that has been added for purification. After adding the water, allow the plants time to become rooted before putting



A simple aquarium.

in the fish or tadpoles. Otherwise the animals may pull up the plants.

One rule for the number of fish in an aquarium is one three-inch fish to a gallon of water. Another rule is an inch of fish for each 20 square inches of water surface at the top. Most people are inclined to put more fish into an aquarium than the amount of water justifies.

Any kind of aquarium fish such as goldfish or tropical fish may be put into an aquarium. However, tropical fish are more difficult to keep than goldfish, and require more attention. The water temperature must be kept above 65° for tropicals, and the feeding must be more regular.

Of the tropical fish, guppies, swordtails, and paradise fish survive well and they have interesting habits. Guppies and swordtails are livebearers. Under favorable conditions, guppies reproduce every six weeks. The bubble-nests of the paradise fish are interesting. Tropical fish and goldfish should not be put together in an aquarium as tropical fish often kill the goldfish. Also the fighting paradise fish must be kept away from other tropical fish.

Some wild fish will survive in an aquarium and they make in-

teresting pets. Small sunfish, bluegills, and bullheads are examples.

Snails should be put into the aquarium to act as scavengers. They help keep the sides of the aquarium clean. Tadpoles will serve the same purpose. Clams also help keep the water clean. If water turtles and small frogs are put into an aquarium, they should be provided with flat pieces of wood onto which they can crawl and get out of the water for air.

The first rule in the feeding of fish is not to overfeed. Only a small amount of food should be given, or as much as will be consumed at that feeding. Food not eaten at once falls to the bottom of the container, sours, and makes the water impure. Goldfish can be fed as seldom as once a week. They should not be fed more than three times a week. Tropical fish should be fed three times weekly.

Oatmeal (cooked), boiled white of egg, cream of wheat (cooked), liver (cooked), beef (cooked or raw), chopped earthworms, and flies are good food for both goldfish and tropicals. These foods are better than artificial food. If wild fish are used, the children should find out about the natural food of these fish and supply it as nearly as possible. Wild fish can usually be fed on earthworms and chopped raw beef. They will also eat live insects placed on the surface of the water.

If the aquarium is balanced, the animals and plants will look healthy and the water will be clear. Cloudy or milky water is probably due to the spoiling of uneaten food, or to decaying plants. This water is bad for fish. Immediately remove the fish and clean the aquarium and replenish with fresh water. In changing fish from one container to another, keep water temperatures the same. Fish cannot stand sudden changes of temperature. Be sure also that tap water has been properly conditioned to remove chlorine.

Fish should be handled with a small net or lifted out in a dish of water. Grasping them with the hands is likely to break the film over the scales and permit fungus to get started. If a fish is diseased, remove it at once and put it into a solution of salt water, in proportions of one teaspoon of salt to a quart of water. It may remain in the solution for a period of several hours. Then put it

into a container of fresh water. Repeat the treatment every day until the fish is well.

The children will get much pleasure and profit from their management of both terraria and aquaria. There are many interesting aquarium books and magazines on the market to which they can turn for lists of animals and plants and for notes on feeding. Also in recent years there has been much interest in amateur tropical fish raising and many of the children may come from homes where there is a tropical fish enthusiast.

HOW TO CARE FOR CATERPILLARS

Some caterpillars spin cocoons, some form chrysalids, some go into the ground to pupate, some spend the winter hibernating in the larval stage. In discussing them with the children, suggest that since the caterpillars they find may not be ready to pupate, they must be sure to bring in some of the leaves on which they find the larvae. Then you will know what to feed them. Caterpillars will leave food and hunt a suitable place when they are ready to pupate. Polyphemus caterpillars may be put into a glass jar that has some twigs with leaves on them. A piece of glass may be laid over the top of the jar. This prevents escape of the caterpillar and also helps keep the leaves fresh. If the caterpillar is still hungry it will eat the leaves. The jar should be cleaned each day and fresh leaves put into it. When the caterpillar is ready to spin, it will use the twigs and sides of the jar as its foundation and spin leaves into its cocoon. When the cocoon is finished, it may be removed from the jar and put into a cool place until spring. Jar and all may be put away. If it is kept in a dry place, the cocoon should be dipped in water once in a while.

Caterpillars like the tomato sphinx (tomato worm) go into the ground to pupate. There should be some garden soil in the bottom of the jar for them. A flower pot with a cylinder of wire screening over it is good, also. Some Woolly Bears hibernate in the larval stage so a terrarium with some dead leaves and pieces of bark makes a good home for them. They will spin in the spring. Some Woolly Bears spin in the autumn.

The Monarch or milkweed caterpillar forms a chrysalis. If the children bring any Monarch caterpillars in, put them into a jar

with milkweed leaves. When ready to pupate, they will spin pads of silk on the underside of a jar lid, leaf, or twig, then hang from it and shed the larva skin, leaving the green chrysalis. Since the caterpillars that form chrysalids in the autumn soon emerge, they may be left in the room for the children to watch. Chrysalids of butterflies that emerge in the spring may be cared for in the same way as the cocoons.

Fruit and salad dressing jars are just as good as more elaborate equipment. The main things to keep in mind are to have fresh leaves of the right kind which are kept from drying too quickly but are not wet, and not to have too much heat. After pupae are formed, they should be placed in a cool place, not moist enough to mold, but not dry enough to kill the pupae. Cleanliness in their care is important, as many caterpillars are susceptible to disease. Also when handling caterpillars, be careful not to bruise them. It is better to let them crawl onto a twig and then move the twig, than to pick them up with your hands.

OTHER ANIMALS IN THE SCIENCE ROOM

The extent to which it may be desirable to keep animals in a schoolroom depends upon the size and facilities of the room, the interests of the children, and the kinds of animals you wish to keep. While some plants and animals if properly cared for are sure to make a room more interesting, we mustn't lost sight of the fact that the children are the most important occupants of the room. If having other animals makes the room less attractive or comfortable for the children, you should either do without the other animals, or choose animals that are easily kept in captivity and cared for.

Directions for the care of aquarium and terrarium animals have already been given. All these cold-blooded animals are clean in their habits and have little or no odor about them.

Small mammals such as rats, mice, guinea pigs, and rabbits may be kept in cages in the room if the cages are kept clean. Cages with removable metal bottoms are more easily cleaned than wooden ones. A cage may be made of an orange crate with a galvanized iron tray made to slide in the bottom of the box. One-

Observing a turtle.

half-inch mesh galvanized wire should be fastened to the open side and a sheltered corner should be made of a smaller box which is placed inside the cage. All animals need to have a place in which to hide.

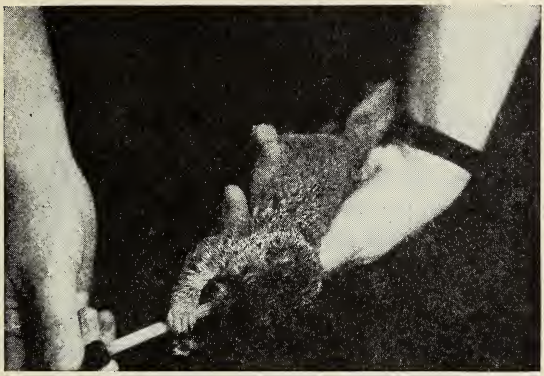
Sawdust or straw should cover the floor of the cage and be replaced with fresh material every day. If a layer of newspaper is put on the floor first, the cage can be more easily cleaned. The animal will carry some of the nesting material into its sheltered corner for a bed.

Guinea pigs and white rats are more easily kept in a schoolroom than rabbits. Rabbits may be brought in for a day or two, but it is better for them to live out of doors.

These rodents may be fed oats, alfalfa hay, carrots, and other vegetables. The young ones should have milk and a few drops of cod liver oil each day during the time when they do not get plenty of sunshine.

If the schoolroom is closed and becomes either very hot or cold over the week-ends, the animals should be taken to the home of one of the children. Extremes of temperature are not good for warm-blooded animals, particularly when in captivity where they can't protect themselves.

Although many of these animals are able to get their water from



Feeding a young squirrel.

their food, water should always be provided in the cages. The container should be low enough for the animal to drink from and of a kind not easily tipped over.

Wild rodents, such as meadow mice, squirrels, and chipmunks are sometimes brought into the schoolroom. Adult wild animals are difficult to tame and often refuse to eat. Young wild rodents, however, may be cared for and make interesting pets. If they are very young they may be fed on warm, diluted condensed milk. The smaller the animal the more warm water should be added to the milk, the more frequently it should be fed, and the less it should have at each feeding. One needs to use common sense in caring for these young animals. Keep them warm, let them alone as much as possible, and don't overfeed them.

Children sometimes bring other young mammals to school. Until the animal is old enough to eat solid food, its care is the same as for the other animals mentioned above. Teachers may find detailed directions for rearing all kinds of wild animals in Moore's *Wild Pets*. See reference list.

Young birds are easily reared if you know the food to give them. Any good bird book will tell the food of the common species of birds. Insect-eating birds may be fed earthworms, caterpillars, and small larvae of beetles. Hard-boiled eggs may be substituted

for part of their food. The shells should be crushed and fed with the egg. Young flickers may be fed on raw eggs and ants.

Seed-eating birds may be fed any kind of small seeds. Chick-feed is easily obtained. Some bread may be given them but should be supplemented with seeds. All birds need sand and other hard foods.

When a bird is first found it may have to be fed forcibly. Open its beak gently and put the food in the back of its throat. A pair of forceps or tweezers is useful in accomplishing this. The bird won't swallow unless the food touches the swallowing center on the back of its tongue.

Fish-eating birds such as bitterns and loons are occasionally found and brought to school. These are problems to feed as they do not thrive on dead fish. The author has successfully fed young fish-eating birds on live tadpoles and minnows.

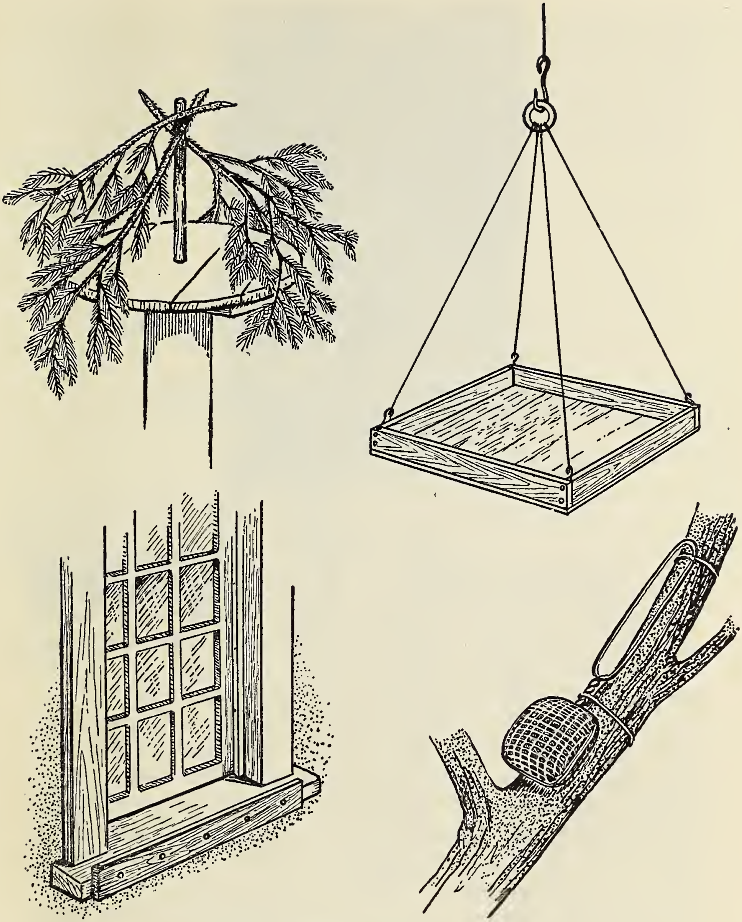
Hawks and owls may be fed pieces of meat which have been wrapped in cotton or rolled in sand. These birds should be handled with care as their bite is painful. Young ones soon learn where their food is coming from and open their mouths.

Unless a wild animal is too young to care for itself, it is wise to keep it awhile for study and then release it. School buildings are not built to house the lower animals. A trip to a well-run zoo will demonstrate how varied are the needs of the different groups of animals. It would be impossible to duplicate these conditions in a room where children live. A cage built outside a window on a level with the window sill will partially solve the problem. If a squirrel or rabbit is to be kept for any length of time this might be worth while.

In caring for any animal, the children should be made to feel responsible. They should read about the natural habitat and food of the animal and try as nearly as possible to duplicate these conditions. Even though some animals die, the value to the children makes caring for them worth while.

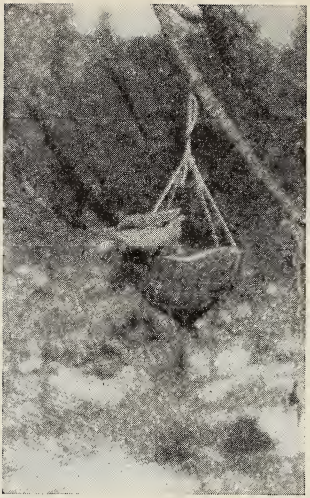
WINTER BIRD FEEDING

In the northern part of the United States most of the common birds migrate in the autumn but there are a few that remain through the winter. Why birds migrate is a question no one has



Simple feeding stations for birds.

solved satisfactorily, although there has been much written on the subject. The teacher should familiarize herself with the theories of migration and not try to solve the problem.



Half a coconut may be filled with melted fat.

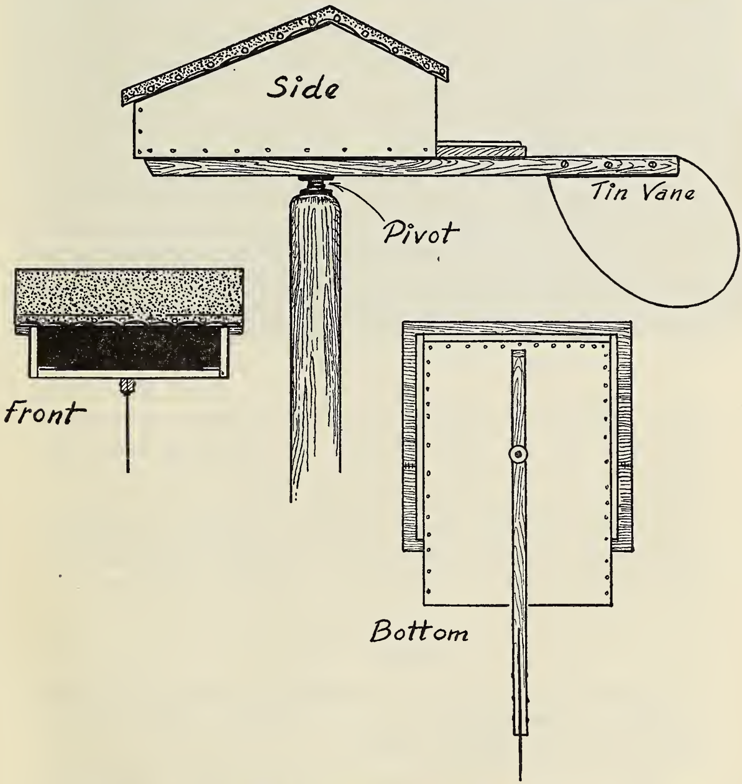
Some winter bird residents stay the year around in the north. Among these are the chickadees, nuthatches, and downy woodpeckers. Others come from farther north, spend the winter, and return to their northern nesting grounds in the spring. Brown creepers, juncoes, and tree sparrows are examples of these.

Some winter birds are insect-eaters and some feed on seeds or fruit. The downy woodpecker is able to chisel through the bark of a tree and with its tongue spear the larvae underneath. Nuthatches and brown creepers get insect eggs and insects from the crevices in the bark. Chickadees and titmice find their insect food mostly in the buds and on the twigs of shrubs or trees. But in winter, all of these will eat whatever they can find. Since they are meat-eaters, we put suet or nuts on the feeding shelf for them. To prevent suet from being carried away by a blue jay or starling, it may be put into a wire basket made of coarse screening.

A soap shaker may be filled with suet and hung from a wire. The suet may be tacked to a tree or tied to a limb. The nuts

should be crushed or finely cracked to prevent squirrels from carrying them away. Birds will scratch among the shells and pick up the bits of nut meats. Walnuts or hickory nuts are good bird food, and may be gathered by the children in the autumn, to save for winter feeding. Half a coconut may be filled with melted fat and hung from a branch. Cracked nuts or seeds may be added to the fat.

Juncoes, sparrows, goldfinches, and cardinals are seed-eaters.



A more elaborate feeding station.

Any seeds, such as wheat, oats, millet, or cracked corn, will attract them. Sweepings from a mill are welcomed by birds and they will scratch in the chaff for days, finding tidbits. Cardinals and grosbeaks are especially fond of sunflower seeds. Crumbs of any kind will attract birds, as will berries and pieces of other fruits. The children can put out discarded apple cores and cranberries. Breakfast food or other cereals which might be discarded because of weevils are good bird food. Even weed seeds are attractive to birds.

Shrubs with berries on them always attract birds. Among these are snowberry, barberry, high-bush cranberry, wild plum or cherry, and bush honeysuckle. Teachers who have anything to do with landscaping the school grounds should see that some such shrubs are planted.

A simple shelf is as effective as a more elaborate one. Just an extension from the window will work, although a roof prevents snow from covering the food. The birds may not come at first, so a good way to get them started is to sprinkle some grain on the ground under the shelf. The sparrows will come first and though we do not care so much for them, they show the other birds the way. A dry doughnut dangling at the end of a string will provide entertainment equal to circus acrobats.

A swinging shelf usually frightens sparrows and drives them away. However, for teaching purposes in the primary grades even an English sparrow has possibilities. It is surprising how many adults do not really know English sparrows.

In snowy, freezing weather, water is as hard for birds to get as is food, so water should be put out for them each day. It will often attract birds not attracted by food. A shallow earthenware container like the saucer of a flower pot is good for this purpose.

FIELD TRIPS

If properly conducted, a field trip may be an important activity to help in the solving of some science problem. Improperly conducted, it may be a waste of time.

A field trip must have purpose. It must come as a result of a need to learn something outside the schoolroom. It need not mean

A field trip—looking for birds' nests.

a long trip. For example, in a discussion of soil formation the question may arise of whether freezing and thawing break up rock and form soil. To illustrate this, the children may go outdoors and find rocks that have been cracked in this way. Even sidewalks and the foundations of buildings illustrate the point.

The teacher should anticipate any trip she plans and make the trip herself before she takes the children. If she intends taking the children to see birds, she should make sure that there will be birds to see. Birds are elusive and cannot be tagged and made to stay in one place. But a nest that is being built, or the work of a woodpecker located by the teacher or some member of the class, will remain until the whole class sees it. With a definite objective in mind, the teacher is sure to prevent disappointment and aimless looking.

Before starting on a trip, the teacher must be sure that every

A field trip—locating territories of birds.

child knows what he is going to look for. There is endless variety in the number of interesting things to see out of doors, but unless the attention is directed to a few, there will be confusion, and no learning will result.

For example, on the way to a river to see erosion, the group may watch for terraces that have been made as the river cut down to its present bed.

A large group should be organized into small units with a leader for each. These may be working on the same problem or different problems. If unusual things are found, the whole group may be called together to see them.

A simple way to organize groups is to make enough slips of paper for each member of the class. Number them from one to five. Circle one one, one two, one three, one four, and one five.

After a field trip—rock study.

Have the children draw slips. All the ones make a group. All the twos make a group, and so on. The children with the circled numbers are the leaders for the day.

Children like to make their own rules for field trips and take pride in following them. Here is a set of rules made by a third-grade class before going on a trip to study birds.

1. Walk quietly. No loud talking.
2. Follow your leader.
3. When you see a bird, stop. When the leader stops, everyone stops.
4. When you see a bird and want to show it to the rest of the group, tell them where it is without pointing. (Birds see better than they hear and are startled by quick motions.)
5. When you are looking at a bird, stand with your back to the sun.

Too many rules are confusing just as too many directions are. It is better to take short trips at first, trying out one rule; then add more rules as longer trips are taken. If the children understand what the trips are for, they will gain the proper attitudes toward them.

It is very important in any science work to respect the discoveries and ideas of children. When they see or find things on a trip, the group should give as serious attention to them as to the teacher's contributions. This encourages children to observe and it intensifies their interest.

On a collecting trip, enough containers should be taken along to carry back any specimens. Directions on how to collect and what to collect should be clearly understood before leaving the school. Collecting should be done only when material collected is to be used. If such material may be studied to better advantage in the schoolroom than out of doors, it serves a purpose. But only as much as is needed should be taken. Gathering hundreds of frogs' eggs would be wasteful when a few would be all the children could care for. It is better to raise a few tadpoles to adulthood than to have dozens die for lack of room or food.

Some of the types of trips may be listed as follows:

1. A trip to locate territories of birds. Return at regular intervals to watch nest building and rearing of young.
2. A trip to collect rocks.
3. A trip to see types of erosion.
4. A trip to find tracks of animals.
5. A trip to find and collect galls.
6. A trip to a zoo or museum to see something that has been discussed in class, such as fossils.
7. A trip to a meadow to collect weed seeds.
8. A trip to observe the sky.

The suggestions for teachers in connection with the stories list other ways to give purpose and variety to field trips. Trips should never grow so common or become so regular as to be monotonous, nor so dull as to be meaningless. Children should always regard them with enthusiasm, not because they offer an opportunity for play, but because they are the most satisfying solution to many of their science problems.

THE HOW AND WHY SCIENCE BOOKS

BASIS FOR CHOICE OF MATERIAL

CHILDREN'S INTERESTS

Children's interests were closely studied in preparing and organizing the material used in The How and Why Science Books. The subject matter was used by the authors in actual teaching experiences over a period of several years and with many different age groups of children. The problems were used in mimeographed form until arranged for publication.

RECENT COURSES OF STUDY

The material for the books was originally chosen from units that appeared in many courses of study from many sections of the United States. City and state courses of study were consulted, as well as those prepared and used in teacher-training institutions. More recent studies, problems which have arisen in the classes of the authors, and new courses of study have added new material to the original series.

The outlines for science in the elementary grades found in the *Thirty-First Yearbook* and in the *Forty-Sixth Yearbook* of the National Society for the Study of Education have been closely followed. Some quotations from the *Forty-Sixth Yearbook* are of interest here:

"Instruction in science should begin as early as children enter school; activities involving science should be provided even in the pre-school and the kindergarten. Through the sixth grade the work in elementary science should consist of a continuous integrated program of the sort advocated by the *Thirty-First Yearbook.* Such a program should provide an expanding, spiral development of understandings, attitudes, and skills, as prescribed in chapter iii."—pp. 41–42

"It is most important that the material selected for each grade of the primary school be balanced to include the elements of learning which represent a rich experience with science. Each level should give the child some opportunity for exploration with content derived from the great major fields of science: astronomy, biology, geology, and physics. This cannot be accomplished by studying only plants and animals.

"There should also be balanced instruction as to the types of activities employed. Children should have a rich opportunity to develop their abilities in discussion, in experimentation, in observing in the out of doors, and in reading for information and motivation. A complete program of instruction in primary science can be maintained only by the full utilization of all these activities, for each plays its part in the development of the purposes of science education."—p. 84

"Since experimentation involves 'learning by doing,' there can be no substitute for it. Pupil experimentation is an essential part of science education. In every course of science offered at any level, therefore, opportunities should be provided for pupils to perform experiments." —p. 53

"The basic purpose of the elementary school is the development of desirable social behavior. Science, with its dynamic aspects, its insistence upon critical-mindedness and better understanding of the world, and its demand for intelligent planning, has a large contribution to make to the content and method of elementary education.

"To accomplish this basic purpose a continuous program of science instruction should be developed throughout public school education, based upon a recognition of the large ideas and basic principles of science and the elements of the scientific method. Children must be given opportunity to gain the knowledge necessary for intelligent and

cooperative experience with the world of matter, energy, and living things and to develop constructive appreciations, attitudes, and interests. This demands that the individuals in our society become intelligent with reference to the place of science in individual and social life.

"When the content and method of science are examined, it is found that the child's normal activities have much in common with the purposes of science in modern society and that the teacher can view the teaching of science as utilizing the natural dynamic drives and potentialities of children."—p. 73

"Work in the primary grades should not be exhaustive. Rather the child should feel that there is more to learn about everything that he does. A developmental point of view demands that a well-balanced program provide contacts with realities. It cannot allow omissions in the development of the concepts, principles, attitudes, appreciations, and interests derived from the field of science."—p. 82

"The new program of science, which emphasizes the development of desirable social behavior, is organized around problems that have social value and are challenging and worth while to children. The teacher must, therefore, look back of the objects of the universe to the problems which involve meanings that the children will need to understand in order to participate intelligently in life. This means that, in science, opportunities must be provided for the development of understandings in all the areas of the environment and at all levels of social needs."—p. 92

HEALTH, SAFETY, CONSERVATION, AND AERONAUTICS AS INTEGRAL PARTS OF A SCIENCE PROGRAM

The authors of THE HOW AND WHY SCIENCE SERIES have made health, safety, conservation, and aeronautics integral parts of the science program. This is in accordance with the recommendations of the *Forty-Sixth Yearbook*:

"*What is the place in the science curriculum of conservation, aeronautics, physiology, and health education?* The materials of these areas are of value chiefly for general education. Except, perhaps, for an eighth-grade one-semester course in health and physiology, it is probably not desirable to offer separate courses in any of these subjects. Their materials can be more effectively integrated with those of the regular courses of the science sequence and with other courses in the program of studies."—p. 46

"The content of the science program in many elementary schools is now being organized around problems which have social value and which are significant in the lives of children. These problems arise from children's

interest in the world around them and from their need to meet intelligently their problems of living in areas such as health, conservation, and safety. They are solved not through the mere accumulation of facts but in such a way as to help children (1) develop meanings which are essential to social understanding, and (2) put into practice desirable social behavior. Problems involve meanings in their solution, and meanings are learned through experiences."—pp. 69–70

"A program in science should develop a large background for the teaching of health. Many schools are now integrating health entirely with science and the social studies. Science provides much of the background for the teaching of health facts and the development of health habits. Moreover, in their study of science, pupils should gain a vision of the potentialities of science in the improvement of the health of the nation and the world."—p. 76

"Likewise, science is involved in accident prevention and safety instruction. We cannot fully anticipate the environment of the future. New inventions may eliminate present hazards and create new ones, making it impossible to develop a code of conduct in safety instruction which will be functional for an entire life span. It may be well, then, in safety instruction to place more emphasis upon the scientific principles which are basic to safe conduct."—p. 77

"The place of science in bringing about the wise utilization of natural resources to the welfare of mankind is an important aspect of the science areas related to the social needs."—p. 77

Health lessons throughout The How and Why Science Books are not labeled as such but take their places naturally as a part of the science program. They are taught also by implication in the illustrations. If health concepts are included in a science book, children learn to assume a scientific attitude concerning health problems. Many science problems are also health problems. The use of the thermometer is taught in science, and it has many implications for health. The germ theories of disease, contagion, and quarantine are all science subjects that are important in health.

Safety is taught both in connection with health and as a part of scientific procedure.

Many activities in science may contribute to the goal of conservation education. Appreciation of the natural and physical world (one of the objectives of all science teaching) should lead

to conservation of wild life and other natural resources. Throughout the books of The How and Why Science Series are such stories as "We Need Soil," "Insect Catchers," "Plants Depend on Animals," "Animals Depend on Plants," "Use—Don't Waste." As in the case of the health and safety lessons, the conservation material takes its place naturally as a part of the science program.

Although World War II gave an added importance to the subject of aeronautics, and a considerable number of separate courses in this field are being taught, chiefly in the senior high school, the authors of The How and Why Science Series believe that this subject can be more effectively integrated with the regular science course. Beginning in the Pre-Primer, the books of the series provide valuable and adequate instruction about the science of flight. Again, this material takes its place as a part of the science program in the study of air and its properties.

THE PLAN OF THE PRIMARY SERIES

SCIENCE THROUGH STORIES AND PICTURES

The books of The How and Why Science Series have a wide scope, including the fields of natural science, physical science, and human science.

The plan of the primary books is to tell stories dealing with the interpretation of natural phenomena common to the experience of children. Science is just as exciting as any other body of subject matter if told in a way that appeals to children. However, the restricted vocabulary of the early grades is often a handicap in presenting what are really simple science concepts. Such concepts can be taught effectively by pictures. In fact, before children can read the words, they enjoy looking at the pictures, and may learn science concepts from them. The books of The How and Why Science Series are beautifully and effectively illustrated. The pictures are reproduced from original water-color paintings by a method so faithful in its reproduction that the illustrations in the books seem themselves to be original paintings.

Nowhere is there a better expression of what appeals to children in the way of books than in the opening chapter of *Alice in Wonderland*:

> "Alice was beginning to get very tired of sitting by her sister on the bank, and of having nothing to do. Once or twice she had peeped into the book her sister was reading, but it had no pictures or conversation in it, and 'What is the use of a book,' thought Alice, 'without pictures or conversation?' "

The books of THE HOW AND WHY SCIENCE SERIES have *pictures* and *conversation.* The pictures are accurate and beautiful. The conversation is natural and interesting.

THE ORGANIZATION OF MATERIAL

The early books of the series are organized seasonally although the units may be taught at any time. Biological units to be natural have to be seasonal.

Most scientific principles are too difficult for little children to understand. But they can understand concepts which may grow from year to year until finally they can be put together to make a principle. For example, the principle that living things have certain modifications of structure which make it possible for them to survive is too difficult for first-graders. But they can observe that animals are doing different things in autumn, winter, and spring. In the second grade they learn more about these animals such as ways in which they survive the winter by hibernating, pupating, and migrating. In the third grade they enlarge the idea to include ways these animals are protected so that they do survive, such as fur, scales, and feathers. Thus as children are able to comprehend larger concepts, they gain them. Eventually they will be able to derive the principle that animals have survived through the ages because of modifications in their bodies that make it possible for them to live in the environments in which they find themselves.

Because the authors believe in the problem-solving method of teaching, the material in the outlines is organized in the form of problems. If the teacher keeps these problems in mind as she teaches, purpose will be given to her work.

ILLUSTRATIVE MATERIAL

Environment and individual differences play such an important part in children's science interests that the teacher must be guided by her own group in the choice of problems. Some problems may have to be teacher-motivated because lack of experience on the

part of her group may mean that the children will not initiate them. Once introduced to the material, children should accept it with interest, otherwise it is not suitable for them.

The teacher who has had little science experience will find help in knowing what may interest her group from the suggestions given in this and other Manuals for the series, but *she should always be ready to follow child-initiated activities when they arise.* She should not be like the teacher who, having planned a lesson on buds, was disturbed when Johnny brought in a turtle. "Take it right back," she said. "Today we are studying buds."

Illustrative material should come primarily from the child's own environment, but not exclusively so. In this regard the *Thirty-First Yearbook,* page 148, states:

> "Some have contended that no illustrative material should be used except that which is in the natural environment of the school. This seems to be a very narrow interpretation of illustrative material. In this day when the child listens to the events happening in Antarctica, or other far parts of the earth, in which his environment is spreading out so that the whole world comes into his own home in one way or another, to restrict the illustrative material to local, indigenous objects seems, indeed, to be inexcusable."

The subject matter of The How and Why Science Series has been arranged to appeal to as many different groups as possible. Biological units have been chosen in such a way that different sections of the United States are represented. Illustrative material is taken from the East, the West, the Middle States, and the South, thus broadening the scientific concepts acquired by the children using these books.

VOCABULARY TREATMENT

Background of experience and facility in the use of oral expression are prerequisites to the understanding of printed material but are not the sole factors involved in reading that material. Word pronunciation and mastery are factors of equal importance.

To this end, the authors of the primary books of The How and Why Science Series have constantly kept in mind the problems of vocabulary mastery. Each new word has been checked against the Stone and the Gates standardized lists of vocabulary for the primary grades to determine the level at which the word should

be used. Adequate and consistent growth in expansion of the child's vocabulary, level by level, has been carefully and scientifically planned.

Each sentence in the books has been analyzed with readability in mind. Length of sentence, sentence structure, difficult words, as well as the nature of the concepts involved have been used as criteria for checking readability.

Such minor points as the one dealing with variations have been taken into consideration in writing the text. For example, if the words "help," "helping," and "helpful" were to be used, the base form "help" appeared first when possible. The variations "helping" or "helpful" appeared later. The singular form of a word appears before the plural form when possible. No compound words, contractions, or variants, except those made by adding "s" were used at the first reading level. The introduction and use of such words were carefully planned at each level throughout the series.

As a teaching aid, a list of new words for each book is given in the back of that book, with an explanation of the writers' plan in the introduction, repetition, and use of these words.

Using the latest research on the problem as a guide, the mechanical aspects of the reading have been as carefully worked out in this series as in any basic reading program.

THE COMPANION BOOKS

There is a Companion Book designed to accompany each of the texts. The objectives of each of the primary Companion Books are to:

1. Extend and enrich certain concepts
2. Develop a scientific way of thinking
3. Promote language growth

To arrive at these objectives the following activities have been planned: coloring (governed by knowledge of concept), cutting, pasting, and freehand drawing; matching of ideas; selecting and evaluating ideas; placing ideas in proper sequence; reading statements and matching them with pictures; reading simple problems and solving them; doing simple experiments and recording data by

pictures or other means on their level; doing simple tests of concepts learned.

Most of the activities in the primary Companion Books are ones that primary children can do alone. However, there are a few that will require a little thought on the part of the teacher, and at least some discussion. The authors are convinced that as the children acquire more skills, new learning should take place—that the Companion Books should not be just testing programs but an application of principles and concepts to new situations; that the lessons should require the using of skills which are necessary in gathering scientific data and solving problems to attack problems similar to those the children have read about in the text. The authors are determined that these books shall not be the busy-work type—all coloring, cutting, and pasting. All the work in the Companion Books, if used as designed, should serve as an aid in determining the accuracy of the concepts.

AN OUTLINE SHOWING THE DEVELOPMENT OF CONCEPTS

Although each Teacher's Manual contains a detailed outline for a year's work, it may be helpful here to show in chart form the plan and organization of the entire primary group of the How and Why Science Series.

In an effort to accomplish this purpose, the chart on the next two pages is presented. It is a master chart to show the organization of all five books. An examination of this chart will show that the entire field of elementary science is divided into three main content areas—those of Living Things, Physical Environment, and Health. The horizontal divisions show how the concepts grow from book to book and contribute to principles in the upper grades. Vertically, each column represents in brief the science program presented in a single book.

A large, more detailed chart is published separately. In this separate chart the horizontal development shows in more detail the growth of the concepts, and the vertical columns present more elaborate outlines of the material covered in each book. This separate chart may be secured upon request.

Content Areas	*We See—Pre-primer*	*Sunshine and Rain—Primer*
LIVING THINGS ANIMALS (*See also detailed chart published separately*) In *WE SEE* these concepts are developed by means of pictures.	There are different kinds of animals. Animals are alive. Some animals will need to be fed in winter. Squirrels, ducks, and turtles all have young. Animals eat many kinds of food. Animals go through changes as they grow.	Animals are affected by the seasons. 1. Animal activities in autumn. 2. Animal activities in winter. 3. People get ready for winter. Animals live in different places, differ in structure, and eat different kinds of food. Animals make tracks in snow or mud by which we can follow them.
PLANTS (*See also detailed chart published separately*)	Plants are alive. Seeds grow when planted. Plants have life cycles. Plants are affected by the seasons—autumn, winter, spring, and summer.	There are different kinds of plants. Plants grow in different places. Plants are affected by the seasons. 1. Trees in autumn. 2. Trees in winter. 3. Trees in spring. 4. Trees in summer.
THE BALANCE OF NATURE (*See also detailed chart published separately*)		Children can make simple homes for animals.
PHYSICAL ENVIRONMENT WEATHER AND SEASONS (*See also detailed chart published separately*)	The earth is made up of land, water, and air. We have day and night. There are different kinds of days. We have four seasons. The change of seasons affects animals, plants, weather, and length of day and night. Air is all around us. We see rainbows in the sky. We see rainbow colors in water.	The land, water, and air are farther away than we can see. We travel on land and water and in the air. Rain, fog, and snow are water. Water has different forms. Length of day and night changes.
THE SKY (*See also detailed chart published separately*)	The sun shines on the earth and makes day. We can see the moon and stars in the sky at night. We are in the earth's shadow at night.	Light from the sun makes us warm. Light from the moon and stars helps you see at night. Sunlight helps things grow.
EARTH STUDY (*See also detailed chart published separately*)	The earth is large. The earth is land, water, and air. Seeds are planted in soil. Air is all around us.	The earth is very, very large. People, other animals, and plants live on the earth. We can travel over the earth.
FORMS OF ENERGY (*See also detailed chart published separately*)	We use electricity in our homes. A magnet pulls some things.	The sun gives us heat.
SOUND (*See also detailed chart published separately*)		
BUOYANCY (*See also detailed chart published separately*)	Boats float on water.	Boats float on water. Kites float in the air.
MACHINES (*See also detailed chart published separately*)	We use machines in our home. Machines make work easier.	A windmill is a machine. Windmills do work.
HEALTH GROWTH CLOTHING BODY—PARTS AND FUNCTIONS CLEANLINESS FOOD POSTURE EXERCISE AND PLAY SLEEP AND REST COMMUNICABLE DISEASES SAFETY REPRODUCTION OF LIFE	Plants and animals need food and air to grow. Wear seasonal clothing. Keep your body clean. Eat the right food. Play out of doors. Cross streets carefully. Do not play in the street. Animals and plants make others like themselves.	All living things need food and air to grow. Seasonal clothing. Ready for school. Good foods. Ways of storing food for winter. Seasonal play. Colds are communicable. Children with colds should stay at home. Going to school. Butterflies reproduce. Bulbs make new plants.

AND WHY SCIENCE SERIES, PRE-PRIMER THROUGH THIRD GRADE

Through the Year—Book I	*Winter Comes and Goes—Book II*	*The Seasons Pass—Book III*
Robins, chickens, moths, butterflies, toads, and mammals all have young. Animals grow and develop. Animals eat different kinds of food and live in different kinds of places. Animals are affected by the seasons. 1. Animal activities in the spring.	Animals are able to survive the changing seasons. 1. Insects 2. Spiders 3. Fish 4. Birds 5. Amphibians 6. Reptiles 7. Crayfish 8. Mammals 9. Earthworms Animal tracks may tell a story.	Animals are protected in many ways. 1. Some animals migrate. 2. Some animals hibernate. 3. Birds care for their young. 4. Some animals are protected by their structure. 5. People help protect birds and pets. 6. People are protected by clothing and shelter. 7. Each animal is fitted to the kind of place in which it lives.
Plants are affected by the seasons. 1. Plants in spring. 2. The bean cycle.	Plants are able to survive the changing seasons. 1. Trees are plants. 2. Seeds are scattered in many ways. 3. Bulbs have stored food which helps them to grow. 4. How seeds grow. 5. How wild flowers survive.	Plants are protected in many ways. 1. Some trees lose leaves and have winter buds. 2. Plants produce new plants in different ways. 3. Plants need soil and water. 4. People help protect wild flowers. 5. Plants need a favorable climate.
A home for water animals.	How to make terraria for caterpillars and spiders. How to make an aquarium.	How to make a terrarium for snails. Aquarium vs. terrarium.
Rivers are enlarged in spring. Heat makes water go into the air. Rain comes from clouds. A thermometer shows how hot or cold the weather is. Wind is air that is moving. Weather changes. Rainbows are made when the sun shines on rain. Rainbow colors may be seen in several places. Fire needs air to burn. The wind, sun, and water affect rocks.	Weather changes. Weather in many places. We read a thermometer above or below zero. Water 1. Evaporation and condensation. 2. Different forms. 3. Effect of lack of water. How clouds are made. Animals and fire need air. The weather vane tells what kind of wind is blowing.	Day and night are caused by the rotation of the earth. Thermometers have many uses. Rainbows 1. Sunlight makes rainbows. 2. Sunlight has all colors in it. Air 1. Air takes up space. 2. Air has pressure. 3. Air expands when heated.
The sun gives heat and light. Colors are in the sunlight. The sun and stars are always shining. Stars are far away. Stars make pictures in the sky. We can tell directions by the sun and stars.	The moon seems to change in size and shape. Star pictures—Big and Little Dippers, Orion, Milky Way The North Star is part of the Little Dipper. The North Star helps us tell directions.	The causes of the moon phases. Constellations—Cassiopeia Dippers Orion Relative sizes of sun, earth, and moon. The needle of a compass points north. A compass helps us tell directions.
Rivers and mountains are part of the earth's surface. We put soil into an aquarium. Seeds need good soil to grow. There are different kinds of rocks.	Tree roots are in soil. Some things dissolve. Some do not. Some things form crystals. Soil holds water that plants use. Caves are made in the earth. The earth is round like a ball. The earth has gravity.	How trees use water from the soil. How soil is made. There are different kinds of soil. How soil is carried. Fossils. Different kinds of rocks have different names.
The wind helps things fly. A magnet will pull things made of iron. Electricity makes some things move.	The sun helps living things grow. The wind does work. A magnet has N and S ends. Electricity makes heat and light.	Heat breaks up rocks. The wind does work. Air pressure can be made to work for us. Lightning is electricity.
		Our ears help us hear sound. A thing must vibrate to make sound.
Some things float. Some things do not float.	Boats float.	
An engine is a machine. Engines do work.	Windmills do work for us. A seesaw does work. Engines help move airplanes. Wheels make work easier.	Levers make work easier.
Living things must have proper care to grow. Proper clothing protects our health. We breathe through our noses. Wash hands to get rid of germs. Germs may make one sick. Cleanliness with food at the seashore. Indoor and outdoor play. Rest after play. Early to bed. Robins, chickens, rabbits, toads, butterflies, moths, and mammals all have young that grow up to be like their parents.	Sunshine helps plants and animals to grow. Seasonal clothing. Care of teeth. Soap and water for cleanliness. What to eat. How to eat. How to stand and sit erect. Play out of doors. How to put out a fire. Insects, plants, amphibians, reptiles, crayfish, squirrels, and birds all have young.	Our bodies need good food, fresh air, and sunshine. Wool, cotton, silk. Eyes, ears, nose, mouth, teeth, skin. Care of skin. Milk and vegetables. Value of good posture. Vacation fun. 8 o'clock for eight-year-olds. Quarantine. How to cross a street. Insects and birds lay eggs. Young mammals are born alive.

WINTER COMES AND GOES—BOOK II

THE PLAN OF THE BOOK

WINTER COMES AND GOES is Book II of THE HOW AND WHY SCIENCE SERIES. It is preceded by a Pre-Primer, WE SEE; a Primer, SUNSHINE AND RAIN; and Book I, THROUGH THE YEAR.

In the construction of WINTER COMES AND GOES, emphasis has been placed on simplicity of concepts and readability. Concepts introduced in the first-grade program have been enlarged and enriched in this book which is designed for use in the second grade.

The vocabulary has been carefully controlled as to introduction and repetition of new words. A planned program with regard to the use of word variants, compound words, and contractions also adds to the readability. Except for the truly "science" words, this book can be as easily read as any basal text in reading, and often with a great deal more interest. The science words, because of their richness of meaning and distinctive characteristics as to form, are more easily learned than such abstract and ordinarily formed words as "when," "was," and "saw." Colorful material that can be read with ease was the major objective used in building WINTER COMES AND GOES.

SCIENCE CONCEPTS AND PROBLEMS PRESENTED IN *WINTER COMES AND GOES*

UNIT A. HOW ANIMALS AND PLANTS SURVIVE THE CHANGING SEASONS

	Story titles in *Winter Comes and Goes*	
PROBLEM I. How are animals able to survive in the wild state?		
1. Insects and spiders	"Looking for Insects"	p. 5
	"An Insect Home"	p. 16
	"Three Caterpillars"	p. 18
	"Eight Legs"	p. 26

2. Cold-blooded animals	"A Funny Animal"	p. 59
	"Jimmy's Surprise"	p. 55
	"A Home for Water Animals"	p. 29
3. Birds	"A Bird Field Trip"	p. 49
4. Furry animals	"Bob's Pets"	p. 64
PROBLEM II. How are wild plants able to survive and propagate?		
1. Some plants produce many flowers.	"Looking for Insects"	p. 5
2. Plants have many ways of dispersing seeds.	"How Seeds Are Carried"	p. 42
3. Some plants have large roots that live through the winter.	"A Long Root"	p. 47
4. Trees have different adaptations.	"Leaves in Autumn"	p. 36
	"Trees"	p. 38
	"Evergreen Trees"	p. 81

UNIT B. THE EFFECTS OF APPROACHING WINTER ON WEATHER AND LIFE

PROBLEM I. How does the approach of winter affect the temperature?	"Colder Weather"	p. 72
PROBLEM II. How does the approach of winter affect water forms?	"Where Did the Water Go?"	p. 68
1. Water evaporates into the air.		
2. Water condenses to form dew.		
3. As days grow colder, frost appears instead of dew.		
4. Then snow and ice come.		
5. Frost crystals may be examined through a reading glass.		
6. Crystals are easily made.	"Jimmy Finds Out Something New"	p. 74
7. Crystals have definite patterns.		
8. Some crystals form in caves.	"Caves"	p. 79
PROBLEM III. How does the approach of winter affect life?		
1. Most animals migrate or hibernate.	"Jimmy's Surprise"	p. 55
2. Many plants lose their leaves and stop growing.		
3. People wear warmer clothes.		

UNIT C. HOW SOME THINGS WORK

PROBLEM I. How do magnets work?	"Christmas Toys"	p. 86
1. Magnets attract iron things.		
2. A knife can be magnetized by rubbing it with a magnet.		

PROBLEM II. What makes things work?		
1. Toys are interesting to study.	"The *Daisy Mary*"	p. 212
2. Some toys are machines (levers).		
3. Electricity makes some things go.	"Christmas Toys"	p. 86
4. Wheels help some things work.	"Wheels"	p. 216

UNIT D. AIR

PROBLEM I. Of what use is air?	"Round About Us"	p. 92
1. There is air in water. Water animals use it.		
2. Animals need air to live.		
3. Boys and girls need air to live.		
4. A fire needs air to burn.		
5. Air is everywhere.		

UNIT E. ROCKS

PROBLEM I. How can we know kinds of stones and their use?	"Finding Rocks Is Fun"	p. 104
1. Stones are different colors.		
2. Some stones are harder than others.		
3. Stones break in different ways; some with sharp edges; some with corners; some stones crumble.		
4. Indians used stones.		
5. People use stones in many ways.		

UNIT F. WINTER ACTIVITIES

PROBLEM I. How can we help some wild animals to survive the winter?		
1. We can learn to know some winter birds.	"Winter Birds"	p. 98
2. Animals' tracks in the snow show what they have been doing.	"A Story in the Snow"	p. 110
PROBLEM II. What can be seen in the winter sky?	"The Moon"	p. 112
1. The different phases of the moon may be observed.		
2. The Big Dipper, the Little Dipper, and the North Star are in the northern sky.		
3. Orion is in the south sky.		
PROBLEM III. What causes weather?		
1. Weather is not alike in many places.	"Weather in Many Places"	p. 119
2. Heat makes water evaporate.	"Water in the Air"	p. 122
3. Cold causes water vapor to condense.	"Clouds"	p. 126
4. Clouds are formed when water vapor condenses.		
5. When water condenses in the air, it makes rain, mist, dew, fog, snow, frost, sleet.		

UNIT G. THE EARTH

PROBLEM I. Why don't things fall off the earth?	"The Earth"	p. 133
1. The earth is round like a ball.		
2. The earth is very large.		
3. The earth pulls things to it.		

UNIT H. SPRING ACTIVITIES

PROBLEM I. How can we tell that spring is here?	"Spring Is Here!"	p. 139
1. We know by the weather.	"The Wind Blows"	p. 129
	"The Weather Vane"	p. 131
	"A Week of Spring Weather"	p. 142
2. We know by plants.	"Susan's Bulbs"	p. 136
	"The Apple Tree in Spring"	p. 144
3. We know by the activities of animals.		
PROBLEM II. What are the spring activities of animals?		
1. Amphibians come out of hibernation and have their young.	"Frogs and Toads and Salamanders"	p. 146
2. Reptiles come out of hibernation and have their young.	"The Horned Toad"	p. 149
3. Crayfish appear.	"The Crayfish"	p. 150
4. Earthworms come to the surface.	"The Earthworm"	p. 199
5. Insects and spiders	"Wigglers"	p. 154
	"The Insects in Spring"	p. 158
	"The Butterfly"	p. 160
	"The Moth"	p. 163
	"Little Spiders"	p. 170
6. Mammals	"Peter and Pan"	p. 186
	"Pets on the Ranch"	p. 206
7. Birds	"Easter Pets"	p. 192
	"The Oriole Nest"	p. 201
PROBLEM III. How are plants affected by increasing warmth?		
1. Seeds germinate and grow.	"How Do Seeds Grow?"	p. 174
2. Wild flowers bloom.	"Some New Seeds"	p. 180
	"Wild Flowers"	p. 182
PROBLEM IV. Why do we need the sun?	"The Sun Helps Us"	p. 178
1. The sun gives us heat and light.		
2. The sunlight helps plants grow.		
3. The sunlight helps people to be well and strong.		

PROBLEM V. How is the spring sky different from the winter sky?	"The Spring Sky"	p. 208
1. The Milky Way is very easily seen.		
2. The Big Dipper is in a different position.		
3. The Big Dipper seems to turn around in the sky.		

UNIT I. WATER

PROBLEM I. How do we use water?	"A Dry Country"	p. 218
1. People need water.	"Water for the Dry Country"	p. 220
2. Plants need water.		
PROBLEM II. What is caused by a lack of water?		
1. Lack of water causes drought.		
2. Lack of water causes irrigation to be needed.		

UNIT J. HEALTH HABITS

PROBLEM I. How should we care for our teeth?	"Susan's Teeth"	p. 66
1. Loose teeth should come out.		
2. New teeth are right under them.		
3. We must care for the new teeth.		
4. We should see a dentist often.		
5. We must not bite hard things like nuts or money.		
PROBLEM II. How can we have good posture?	"Stand Up! Sit Up!"	p. 102
1. We must sit straight.		
2. We must stand straight.		
PROBLEM III. How should we eat?	"How to Eat"	p. 211
1. We should always be on time for meals.		
2. We should eat slowly.		
3. We should chew our food well.		
4. We should not eat too much.		
5. We should not play hard right after eating.		
PROBLEM IV. How can we keep well?	"The Sun Helps Us"	p. 178
1. We can work and play in the sunshine.		
2. Sunshine is good for us.		
PROBLEM V. How shall we keep clean?	"Nancy Goes to a Party"	p. 84
1. We should bathe often.		
2. We should wash our hands before eating.		
3. We should wear clean clothes.		

ACTIVITIES USEFUL IN SOLVING THE PROBLEMS IN *WINTER COMES AND GOES*

LOOKING FOR INSECTS

Pages: 4–15

Concepts:

An insect has six legs.
A butterfly is an insect.
A bee is an insect.
Some bees die before winter.
Others stay in their hives all winter.
Bees store honey in their hives for food.
A caterpillar is an insect.
A caterpillar has legs; worms do not have legs.
A grasshopper is an insect.
Grasshoppers lay eggs in autumn and then die.
The eggs survive the winter.
Grasshoppers harm farmers' crops.
An ant is an insect.
Ants live in the ground all winter.
Spiders have eight legs.
Spiders are not insects.
Goldenrod is made up of many small flowers.

Suggested Activities:

This field trip is used as an introduction to the book. A teacher might easily use a similar trip to motivate her science work. The purpose is to illustrate a method of teaching, as well as to help the children draw conclusions. The activities suggested in the story are easy to carry out. The teacher will find help on how to care for caterpillars in the first part of this Manual.

The Monarch butterfly is used because it is common; its larva is often found in September on milkweed plants, soon forms a beau-

tiful chrysalis, emerges in a short time, and flies south to hibernate. The teacher can find much information on this butterfly.

The carrot caterpillar is found on carrot leaves, on wild and garden parsley, and on other members of the carrot family. Its interesting habit of sticking out two orange-colored horns from which come an odor of caraway makes it a favorite with children. It is easy to care for, and it illustrates the life history of a butterfly. The adult is the familiar black swallowtail butterfly.

The big green caterpillar which the children find on the apple tree is the larva of the well-known *Cecropia* moth. It is a very large caterpillar, being about four inches in length. The cocoon is usually spun on branches or twigs of trees or shrubs, never on the ground under the leaves. The cocoon is double and suspended like a hammock.

Although Miss Brown discourages taking ants back to school, it is easy to make an artificial ant nest. Simply dig up part of a hill and put it into a fruit jar. Tie a piece of heavy paper around the jar to keep out the light. Stand the jar in water to prevent escape of the ants. A small piece of sponge on top of the dirt in the jar may be moistened occasionally to supply water. Some cake crumbs, sugar, or dead insects will furnish food. If a little paper box is put on top of the soil the ants will fill it with debris.

The Monarch butterfly on page 6 may be seen in color on pages 56 and 57 of SUNSHINE AND RAIN. The concept that insects have six legs is important only because it gives the children a tool to help them in identifying insects when they desire. The children are usually surprised to learn that caterpillars are insects and not worms. They may raise the point that caterpillars seem to have more than six legs. Caterpillars have three pairs of true legs and several pairs of abdominal fleshy legs (prolegs). The caterpillar is, of course, a young insect. The adult, a butterfly or moth, has six legs which are always plainly seen.

The children are also surprised to learn that a spider is not an insect. It is enough for them to know at this time that a spider is not an insect because it has eight legs instead of six. Another difference between insects and spiders is that insects have three parts to their bodies whereas spiders have only two. Also, the bodies of insects change their form before they grow up; spiderlings look like adults when they hatch.

AN INSECT HOME

Pages: 16–17

Concepts:

A gall is an insect home.
Galls are often found on goldenrod stems.
A tiny moth lays an egg on the stem.
The egg hatches into a caterpillar.
The caterpillar goes into the stem.
The caterpillar causes the stem to grow big.
The caterpillar stays in the gall all winter.

Suggested Activities:

Galls of various kinds may be kept through the winter in glass jars or terraria. Any insect pupae should be kept cool or they will develop too soon. If a gall is opened now and then, children may see the stages in the development of the moth, wasp, or fly that it contains. Each kind of gall is caused by a specific insect, so there will be an element of suspense as the children wait for the insect to emerge.

There are two kinds of goldenrod galls, a round one caused by a fly and the kind pictured on pages 16 and 17 which is caused by a moth. This moth is *Gnorimoschema gallaesolidagus,* or *solidago gall-moth.*

In different regions, different kinds of galls may be found. Any bumps that one sees on twigs, leaves, or buds of trees, or on stems or leaves of other plants, may be examined for insect inhabitants. If many growths of the same shape appear, they are probably galls. But the galls caused by different kinds of insects are not alike. Some of the most common galls are found on rosebushes, oak trees, and willow trees.

THREE CATERPILLARS

Pages: 18–24

Concepts:

A home should be made for caterpillars brought to school.
Caterpillars should be fed.
The milkweed caterpillar eats milkweed leaves.

The carrot caterpillar eats carrot leaves.
The big green caterpillar (Cecropia) eats apple leaves.
Some caterpillars make chrysalids.
The milkweed caterpillar makes a chrysalis.
The carrot caterpillar makes a chrysalis.
Some caterpillars make cocoons.
The big green caterpillar makes a cocoon.
Chrysalids and cocoons are winter homes for caterpillars.

Suggested Activities:

The purpose of these pages is to teach conservation of wild life. Often, in their eagerness to collect, children bring so much live material to school that it is neglected. Although the story is about three specific common insects, the teacher may use any caterpillar to introduce and teach the life histories of moths and butterflies. She will find suggestions under a separate chapter in the Manual. Part of the value of this type of activity lies in the care the children give to the caterpillars and the observations they make. Caterpillars should not be allowed to dry out in a cardboard box.

Technically, the word "sleep" is not correct when speaking of hibernation, so "rest" is used. The word "hibernate" is introduced later in the book, but it can be used orally here.

Cecropia caterpillars feed on the leaves of several kinds of trees but they also thrive on lilac leaves. These are often more available than tree leaves.

WHAT IS IT?

Page: 25

This is a review page. The answers are (1) a grasshopper; (2) a gall; (3) a chrysalis; (4) a carrot caterpillar.

EIGHT LEGS

Pages: 26–28

Concepts:

Spiders brought to school should be cared for.
A box may be made into a good home for a spider.
Spiders need food and water.

Spiders use insects for food.
Some spiders spin webs.
They catch insects in their webs.
Some spiders make a silk rug on which they lay their eggs.
They make the rug into a bag.
Little spiders come out of the bag in the spring.
Some spiders die after they lay their eggs.

Suggested Activities:

This story continues the idea of conservation. Spiders may be kept alive in a terrarium or glass jar if live insects are given them. Any kind may be captured in a jar but the garden spiders make the prettiest webs. By counting the insects fed to them the children may be able to see how valuable spiders are. This is a good opportunity to destroy unreasoning fears of spiders. Children are not likely to fear animals they have fed and cared for. Since most spiders are harmless and only one in the United States, the Black Widow, is actually poisonous to man, spiders should be protected. The egg cases of spiders may be kept through the winter and the little spiders allowed to emerge in the spring.

The cases should be kept in covered containers such as large fruit jars, or the teacher may be dismayed to find hundreds of tiny spiderlings making threads all over the storeroom or corner where they have been kept. In a jar, the children may observe them, then release them out of doors.

Children should not be encouraged to handle spiders but to capture them in jars. Holding the lid in one hand and the jar in the other, quickly catch the spider between jar mouth and lid.

A HOME FOR WATER ANIMALS

Pages: 29–35

Concepts:

An aquarium is a home for water animals.
A good aquarium is like a natural pond.
It has plants as well as animals in it.
Snails are good animals to keep in an aquarium.
A fish uses its fins and tail to help it swim.

Fish have scales.
Scales help protect the fish from being hurt.
A fish's eyes are always open.
A fish can see in water.
A fish can breathe in water.
Some fish can live in very cold water through winter.
Sunfish will eat earthworms.

Suggested Activities:

This story should add to the children's understanding of the adaptations of animals to different environments, and the balance of nature. A complete chapter on how to make an aquarium will be found at the beginning of this Manual.

If it isn't possible to have a large aquarium, a large jar, such as a gallon pickle or coffee jar, may be used as a home for one fish. A small perch, sunfish, or goldfish will live all winter in such an aquarium if it is properly made. Individual aquaria are fun for children of this age to make. A large-mouthed pint jar will make an aquarium large enough for a tropical fish, such as a guppy. Since one pair of guppies reproduces rapidly, every child could soon have a fish if the original aquarium is made in autumn.

Such questions as, "Why do you need to have plants growing in your aquarium?" and, "Why not use tap water?" will help to direct the activity.

This story contributes concepts which are necessary to an understanding of the principle that animals have modifications of structure which make it possible for them to survive. In the first grade the children made some general observations of the ways in which the structures of birds, insects, amphibians, and mammals helped them to live in different places. Primary children are not interested in the structures but in how they function. So the teacher's questions should stimulate interest in watching the animal to discover how it lives, moves, breathes, and eats. With a live fish before them, questions like, "The fish doesn't have any legs; how does it move up and down in the water?" may be asked by a child. When we can set the stage well enough to provoke such questions, all we need to do is to follow with counter questions like, "How do *you* swim? Does the fish have anything that moves the way you

move your arms and legs?" If questions don't come spontaneously from the group the teacher may have to start the thinking by asking, "What does the fish have which helps it to live in the water?" "How does its shape help it?" The observation and discussion should precede the reading. New words may be easily taught during this observation-discussion period. The teacher may then say, "There is a story in your science book about a fish. We can read it to see if the boys and girls in the story knew as much as you do." The last part of the story may be used to answer questions on what to feed the fish.

In teaching about animal or plant adaptations, be careful not to let children gain the wrong concept—that living things develop structures in response to a need. The fish, for example, didn't grow fins because it needed them to swim. The paired fins of fish are modified limbs, similar to the legs of other vertebrates. Fish belong to the lowest class of vertebrates and scientists believe that those we have today survived because they *had* fins, gills, and other characteristics that made life in the water successful and competition for food possible. They believe that this is true for all animals except man. Man has the intellectual development by which he can foresee and plan, but even he hasn't been able to change his actual physical structure. Of course, all of this is beyond second-grade children, but if an adult doesn't give them misconceptions, children are not likely to have them.

LEAVES IN AUTUMN

Pages: 36–37

Concepts:

The leaves of some trees fall off in autumn.
Many leaves are brightly colored.
Different trees have different kinds of leaves.
Four kinds of leaves are the maple leaf, the oak leaf, the elm leaf, and the poplar leaf.

Suggested Activities:

Children are always bringing in colored leaves in autumn. Often teachers use these for decoration by waxing or shellacing them.

They may be used to stimulate an interest in the changes that are taking place in trees. All the leaves that are the same shape may be put into one pile. Children can play matching games or "hunt the tree." If they compare all of the leaves in one pile, as maple leaves, for example, they will find that while they all conform to a pattern, no two are exactly the same size and shape. This contributes to the concept of variation in nature.

The labels are put under the pictures of leaves for the teacher's benefit. Children are not expected to read them unless they already happen to know them.

The teacher should go only so far with identification as the children's interest leads. Children should never be required to memorize names of things. If, as they spontaneously bring in leaves and want to know their names, the teacher instead of telling them at once, helps them to find a matching picture, the name will probably stick. The important concepts here are that trees differ in kind and as individuals; are living things that breathe, feed, grow, and survive the winter. These concepts are further developed in the story which follows.

TREES

Pages: 38–41

Concepts:

A tree is a big plant which grows from a seed.
A tree has many parts—trunk, branches, leaves, roots.
In autumn some tree leaves change color and fall off.
A tree has new leaves every spring.
The roots are under the ground.
There are almost as many roots as branches.
The roots get food and water for the tree.
Roots hold the tree in the ground.
Trees have many uses—they make shade in summer; they make good playhouses; they are homes for birds; some trees have fruit that we eat; trees furnish wood.

Suggested Activities:

Through observations and discussions of trees, children will add to their concepts of seasonal change. Their attention should be drawn to the likenesses and differences between evergreen and

deciduous trees. If there should be a storm and a tree is uprooted or any other opportunity arises to see the roots of a tree, the teacher may take advantage of it to show the children how much of the tree is underground. Children may also make a collection of things that are made from trees or come from trees.

Review here the reasons why leaves change color and fall off, as given in the Manual for SUNSHINE AND RAIN under the lesson, "A Walk." Review also the fact that the leaves of evergreen trees do not change color and that these trees stay green all winter. However, evergreens lose their *old* needles each fall. Look at the needles of an evergreen and compare them with the leaves of a deciduous tree as to shape, color, and the way in which they are fastened to the twig. Bring out the fact that the shape of the needles makes an evergreen tree able to survive heavy snows. If other trees kept their leaves this snow would lie on the leaves and break the branches. Also, the broad, flat leaves would freeze while the thick, wax-coated evergreen needles do not.

HOW SEEDS ARE CARRIED

Pages: 42–46

Concepts:

The wind scatters some seeds.
Milkweed seeds are scattered by the wind.
Milkweed seeds have plumes.
The plumes help the seeds float in the wind.
Dandelion seeds have plumes, too.
The wind blows them to their new homes.
Animals scatter some seeds.
Squirrels carry nuts.
Birds scatter seeds.
Burrs are carried on the fur of animals.
Some seeds fall into water and float to their new homes.

Suggested Activities:

Seed dispersal has been taught for so long in the primary grades that most teachers are familiar with activities to use in connection with this story. Children will collect different types of seeds, discuss the ways they may be carried and find examples of these

ways. They should discuss the advantage to the plant of having seeds scattered. They could count the seeds on some plant like a bean plant and discuss the possibilities of their growing if they fell right under the plant.

No effort should be made to mount large collections. Most of the observation is best made out of doors. Children are usually especially interested in seeds that are carried by wind. If a milk-weed pod opens in the classroom, the teacher may find her children bobbing around like corks as they blow the little parachutes. Such an activity is better performed out of doors.

An interesting activity is to take the children to some tree which has winged seeds, such as maple, box elder, ash, catalpa, or elm and send them radiating out in a circle to search the ground for all of the seeds they find, like the seeds on that tree. Try to do this with an isolated tree, with no others like it anywhere near. Tell them to go as far as they find seeds, then measure the distance to the tree by pacing and counting the number of paces. That will give some idea of how far seeds from a tree are carried. Each child may count the seeds he has found. The teacher should help them count to discover how many seeds were in the area covered.

The three main types of seed dispersal are interesting for the children to know. The children will think of other examples of these methods than those given in the story. The seeds illustrated on page 45 are as follows:

The seeds which have wings—ash, elm, box elder.
The seeds which float—maple, catalpa, basswood.
The seeds which have plumes—milkweed, dandelion.
The seed carried by an animal—hickory nut.

It should be pointed out that seeds may be dispersed in more ways than one. For example, those with wings may be carried in water and vice versa. Also, any seed may be carried by an animal.

The tree seeds illustrated on page 46 are maple (wing), acorn (animal), coconut (floats).

Children may also try to float different kinds of seeds on water. They will discover that most seeds will float.

They should then discuss which ones are likely to grow near enough to water to be carried that way.

A LONG ROOT

Page: 47

Concepts:

Some plants live all winter.
The dandelion lives all winter.
It has a long root.
The root has food in it.
The food makes the leaves stay green.
The winter leaves of a dandelion are not like the summer leaves.

Suggested Activities:

If the children do just what Jimmy did and try to dig up a dandelion they will be surprised to find such a long root. If they put several in jars of water the plants will continue to grow. The plants will use the stored food for this growth. The children should gain the concept that plants not only survive by producing seed, but that some plants live through the winter on stored food.

In late autumn an interesting field trip may be taken to look for the winter leaves (rosettes) of some of the weeds similar to the dandelion. These lie flat on the ground in a circle around the dead stem. It is these leaves, ready made, which often survive the snow and start activities in the spring. This is the reason why dandelions seem to spring up overnight. They don't have to grow leaves, just start producing flowers—and more leaves.

The children will discover that all such plants have long, thick roots in which food is stored. Many weeds survive in this way.

A BIRD FIELD TRIP

Pages: 48–53

Concepts:

Many birds can be seen in autumn.
Birds have feathers.
Feathers cover the skins of birds.
Feathers and wings help birds fly.
Birds with short, thick beaks are usually seed-eaters.
Goldfinches and sparrows are seed-eaters.
Birds with pointed beaks are usually insect-eaters.

A downy woodpecker is an insect-eater.
Birds' nests may be collected in autumn.
A robin's nest is round. It is made of mud, grass, and string.
An oriole's nest is like a basket. It is made of milkweed stems.

Suggested Activities:

This field trip is to help teach protective adaptations of birds. Actually several trips should be taken to observe the different points brought out in the story.

Discuss how birds live; how their feathers help to keep them warm; how feathers help birds fly; how birds' beaks help them get different kinds of foods; how their feet help them.

Autumn is a good time to collect nests. Children are usually curious about nests and we discourage their touching nests in the spring or summer. After the birds leave their nests, the nests may be taken. Many nests cannot be identified accurately unless we see the birds build them, but the ones mentioned in the story are easily identified.

The children may take nests apart to see how difficult it was for the birds to make them. They may also identify the materials such as grass, mud, horsehair, or fibers.

The principle towards which these concepts build is that animals have modifications that help them survive. We do not expect primary children to know that principle. The examples are brought out from time to time, and thus the concepts grow.

The seed-eating birds illustrated on page 50 are the sparrow, the house finch, and the junco. The insect-eaters on page 51 are the brown creeper, the chickadee, and the downy woodpecker. Bird books and guides will furnish many excellent illustrations and diagrams of beaks. While the beaks determine the type of food the bird is fitted to eat, most birds will eat other kinds of food when hungry.

Goldfinches are sometimes called "wild canaries." They are related to the domesticated canary, but are true wild birds. However, if there is a canary in the schoolroom, it will illustrate the structural characteristics of a seed-eating bird. The children can observe its short, thick beak and watch it crack seeds. They may also notice the weak legs and feet, fitted only for perching.

This story will help answer questions that arise when on a field trip. If nests are seen, they may be compared with the pictures in the book.

WHICH IS RIGHT?

Page: 54

Teaching Suggestions:

This is a review page with some questions of a multiple-choice type. The answers are: (1) sunfish; (2) duckweed; (3) spider; (4) milkweed, dandelion; (5) bird; (6) robin; (7) goldfinch; (8) bee; (9) snail.

JIMMY'S SURPRISE

Pages: 55–58

Concepts:

A salamander has short legs on a fat body.
Its tail is long and thin.
It lives part of its life on land.
It always lives near water.
Salamanders, toads, and frogs are alike in many ways.
They have smooth skins.
They cannot turn their heads.
Salamanders differ from lizards in that lizards have scales and can turn their heads.
Salamanders, toads, and frogs hibernate.
Snakes and turtles also hibernate.

Suggested Activities:

In preceding books of this series, the children became familiar with frogs and toads and learned something of their life histories. The story in this book introduces another amphibian often found in moist woods, around lakes and streams, and under rocks in damp places.

Salamanders are frequently confused with lizards, which they resemble in shape. Their lack of claws, their smooth instead of scaly skin, and fleshy instead of bony tail differentiate them. In this story an effort is made to add to children's knowledge of animal

grouping, and the modifications that adapt the animals to the life they lead.

If possible, the teacher should locate a place where salamanders are found. In autumn salamanders crawl into rotten logs, bury themselves in moss, or hide under leaves and stones in moist meadows and woods. All amphibians must keep their skins moist as they get part of their oxygen through their skins. Toads have a layer of spongy cells that help prevent evaporation, but even they can't stand too much dry air. Salamanders are not usually found in dry regions, but close relatives, mud puppies, are found in irrigation ditches and streams. Any member of the group will illustrate the characteristics of this class, as well as contribute to the concept of hibernation.

Seeing the salamander, frog, and toad together on page 56 will help the children remember them as animals which are alike in many ways. This is a lesson in which an attempt is made to teach protective coloration. The artist has shown at the top of page 57 how the toad and salamander look like the ground. At the bottom of page 57, the green frog hides in the grass easily because it looks like the grass.

Salamanders may be kept alive in a "woods" terrarium. Keep a cover on the terrarium to insure the moist air the animal needs. Have a piece of wood or rotted log in one corner for the salamander to hide under. Feed it on live insects, either larvae or adult forms.

Little red-spotted newts, sometimes sold in pet shops, belong to this class. They differ from our common salamanders in that they return to water after spending one stage on land. If one is brought to school, a jar of water should be sunk in the soil of the terrarium. Other salamanders can get along with a dish of water. Newts eat snails and other small water animals.

A FUNNY ANIMAL

Pages: 59–63

Concepts:

Where Mexican children live, the weather is warm all the year.
It does not rain often.
The ground is very dry.

The horned toad lives in the dry country.
The horned toad is gray and brown.
It looks like the ground.
Horned toads make good pets.
They should be kept in a terrarium with sand in it.
They will eat insects.
Horned toads hibernate.
The horned toad is not a real toad—it is a lizard.

Suggested Activities:

The so-called horned toad is found all through the Southwest. It is an interesting lizard that has been misnamed a toad. The story is put into the book as an illustration of a reptile that is harmless and that makes a good pet. Its protective coloration and quick movements are examples of adaptation.

Should some child bring a horned toad to school, it may be put into a desert terrarium and fed live insects. Horned toads will eat mealy worms, flies, ants, earthworms, and other live food.

Since this follows the story of a salamander, it may be used to compare the two classes of animals. The children should, if possible, have a toad and horned toad to observe. The teacher may say something like this, "Animals often have names that are not correct. The person who named this animal thought that it looked like a toad. Can you tell why?" After the children have discussed the horned toad and the ways it looks like a toad, the teacher may continue, "Perhaps you have better eyes than the person who named it. You may know more about toads. I wonder if anyone would like to tell why he thinks it is not a toad. He may come up and look at both the real toad and the horned toad." After several children have given their ideas based on their observations, they may read the story to see if they were right.

Children should be checked on their observations. If they aren't careful and accurate, this is a good time to teach them to be. "Look again, Jimmy. Are you sure that the toad has scales? How can you tell? Feel its skin," directs Jimmy's attention to important details.

If horned lizards are not available, any kind of lizard may be used, even the so-called chameleons sold on chains! If the teacher happens to know someone in the Southwest, she may get a horned

toad, as did the children in the story. They are easily sent in a cardboard carton with a loose packing of some kind. The author once received thirty, packed in cotton bolls! After being studied they may be released. They seem to survive, even in the northern part of the United States.

BOB'S PETS

Pages: 64–65

Concepts:

Rabbits, dogs, and cats make good pets.
A rabbit has soft fur.
It has sharp claws.
It digs in the ground with its claws.
Rabbits have sharp teeth.
They gnaw plants and vegetables with their teeth.
They do not eat meat.
Dogs and cats eat meat.
They have the kind of teeth that can tear food.

Suggested Activities:

This story is included to show the adaptations of cats, dogs, and rabbits.

The children should have a dog and cat to compare as to teeth, eyes, feet, fur, and behavior. Cats and dogs are flesh-eating animals with sharp, pointed teeth that tear.

It is interesting to notice that a cat's face is flat, more like a human being's than a dog's. Both eyes see the same object. The noses of most dogs interfere with this type of vision. By putting their hands together over their noses, children can approximate a dog's nose. Let them discuss the difference it makes in what they see. Discuss how this affects the difference in the hunting habits of cats and dogs. Dogs use scent more than sight.

Rabbits have chisel-like incisor teeth which they use in gnawing their food.

SUSAN'S TEETH

Pages: 66–67

Concepts:

Children should take care of their teeth.
Baby teeth should be pulled out.
If they are not pulled, the new teeth will not be straight.
It does not hurt much to have baby teeth pulled.
Teeth should be brushed every day.
Cavities in teeth should be filled.

Suggested Activities:

Following a study of other animals' teeth, children may learn about their own teeth. They can see that they have some teeth like a dog's teeth and some like the rabbit's. They should discuss the way these animals use their teeth and compare with their own way of using the teeth.

Since seven-year-olds are losing teeth, they are interested in them. If they can see a picture of an X-ray showing permanent teeth pushing up under the baby teeth, it may help to relieve any fears they may have. A dentist usually has such a picture which he will loan. In such a picture they can see that the roots of the baby teeth are dissolving, so there isn't much to pull. However, teeth shouldn't be pulled until they are ready to come out.

WHERE DID THE WATER GO?

Pages: 68–71

Concepts:

Dew is water.
When water goes into the air, we say it evaporates.
Heat makes water evaporate.
Frost is frozen water.
Frost melts and the water evaporates.
Frost looks something like snow.
Frost crystals can be seen through a reading glass.

Suggested Activities:

The concept of evaporation has been taught before but the word hasn't been used. Since many of the children reading this book will not have had the experiments suggested in THROUGH THE

Year, the teacher should look up the suggestions on evaporation given in the Manual for that book.

Although frost is frozen water, it isn't the same as frozen dew. It is formed much as snow is formed, by the condensation of water vapor at a temperature below freezing. The vapor forms ice crystals that may build up beautiful patterns. If possible let the children look at the crystals through a reading glass and compare them with snowflakes. They will see that frost is made of ice crystals, which take different forms according to the temperature and amount of moisture in the air. The crystals may be tiny needle-like crystals, or like little six-sided plates of glass. On windows the crystals form feathery patterns, following dust or other particles on the panes. Always, the crystals will be six-sided, but only rarely can the number of sides be seen. Heavy hoar frost sometimes forms in very large crystals.

Frost and snow afford an excellent opportunity to teach appreciation of the beauty of natural phenomena. While we do not believe in the sentimental type of appreciation, we do believe that the pleasure to be derived from appreciation of a beautiful winter scene has definite value. Being able to see the patterns of frost and snow leads to a deeper appreciation, based on understanding.

COLDER WEATHER

Pages: 72–73

Concepts:

A thermometer tells how cold or how warm it is.
The red line is short in cold weather.
It is long in warm weather.
There is a place on the thermometer called zero.
We read a thermometer above or below zero.
If the red line is at zero the weather is very cold.
70 above zero is about right for a schoolroom.

Suggested Activities:

Although the children may have learned that the red line is lower when it is cold than when it is warm, they have not learned how to read it. They still would not understand degrees, so in this

story even numbers are used to express the position of the red line. The teacher should see that there is a thermometer with figures large enough for the children to read. They may experiment by putting it in different places.

If the children keep a daily weather record, they begin to get the idea of the sequence of weather changes.

If children have questions about what makes the liquid go up and down, let them experiment with a thermometer. A bath thermometer may be used. Let someone hold his hand on the bulb and watch the liquid rise. Then put it in cold water and watch it go down. Discuss the fact that water or milk may boil over the top of a pan if the pan is too full. They should be able to come to the conclusion that the liquid in the thermometer takes up more room as it is heated and less room when it is cooled.

JIMMY FINDS OUT SOMETHING NEW

Pages: 74–78

Concepts:

Some things dissolve; others do not.
Sugar and salt dissolve; flour and sand do not.
When salt water evaporates, salt crystals remain.
When sugar water evaporates, sugar crystals remain.
Crystals have patterns.
Salt crystals, sugar crystals, frost crystals, and snowflakes have different patterns.

Suggested Activities:

Simple experiments on solution will help to develop the concept of the word "dissolve." The children should try putting different things into water to discover that some things dissolve and some do not. Some table salt has starch in it. When stirred in water, the salt dissolves but the starch settles to the bottom. If this happens the children will be confused, so the teacher should try the experiment first to see if she has pure salt. Cheaper salt, which comes in bags, is better for these experiments.

The teacher should provide an experiment to show formation of crystals. This is easily demonstrated by using alum. Dissolve one cupful of alum in two cupfuls of hot water. Pour the hot solution

into a fruit jar. Hang a weighted string into the solution. Don't move it after it starts to cool. As the solution cools, crystals will begin to form on the string. As the water evaporates, more crystals will form. The string may be lifted out to show the crystals.

Making crystals helps children understand the formation of ice crystals. Salt crystals may be made by evaporating a salt solution. Sugar crystals are formed when water in syrup evaporates.

Every mineral that crystallizes has its own crystal pattern. Salt crystals are cubes. Ice crystals are regular, hexagonal prisms. Sometimes they are long needle-like prisms. Sometimes they are short, plate-like prisms. When crystals form a snowflake, they collect around a nucleus of dust and make the intricate patterns we see. When frost forms, the molecules of water vapor use the surfaces of plants upon which to construct their prisms.

Refer to SUNSHINE AND RAIN, page 17, for pictures of snowflakes.

CAVES

Pages: 79–80

Concepts:

Crystals are often formed in caves.
Caves are made in rocks.
They are made by water dissolving part of the rock.
The rocks are in layers.
Some layers are softer than other layers.

Suggested Activities:

The purpose of these pages is to help answer a question often asked by primary children. They cannot understand all about the formation of caves any more than they can understand the chemistry and physics back of crystal formation, but they should have an accurate answer at their level of interest and comprehension.

This material may be used any time after the children have made crystals, or when someone brings such a crystal to school and asks about its formation. If the lesson is teacher-motivated, the teacher should have a stalactite, stalagmite, or crystal from a cave to show the children. These crystals are often made of calcium carbonate, a pure form of limestone, but other minerals

are sometimes found in caves. The name of the mineral doesn't matter. The important concept is that it is rock material—a part of the earth. It extends the child's understanding of his environment and increases his appreciation of it.

The children may want to try to dissolve these rock crystals in water. They will discover that they will not dissolve in pure water. They should read again page 80 and discuss the fact that it took many, many years for the rock to dissolve. The teacher may say something like this, "Do you suppose that water which goes down through the earth is just water with nothing else in it? Might it have something in it which will dissolve rock?" If she wishes to do so, she may add a few drops of hydrochloric (muriatic) acid to the water in which the crystal is placed, telling the children that it is an acid. If the crystal is calcium carbonate, the diluted acid will start to dissolve it. She may then explain to the children that water going through the earth may become acid. They can figure out what it would do to some rocks.

Actually, rain water dissolves carbon dioxide from the air and makes a weak carbonic acid, which over a period of years dissolves limestone. This is a chemical reaction which results in the formation of caves, stalactites, and stalagmites. No attempt should be made to teach any more than is necessary to answer the children's questions.

If there is any place near where the children can see layers of rock or soil, they should visit it. Excavations for buildings, road cuts, river banks, and gravel pits are good places to see these layers.

EVERGREEN TREES

Pages: 81–83

Concepts:

Evergreen trees stay green all winter.
Evergreen leaves are pointed and sharp like needles.
Evergreen trees have straight trunks.
Evergreen trees make good shelters for winter birds.
Evergreen trees have cones.
Seeds are in the cones.
There are different kinds of evergreen trees.

Pine trees have needles fastened together in bundles.

Fir trees have needles that are flat, and not fastened in bundles.

Fir trees make the best Christmas trees.

Suggested Activities:

Near Christmas is a good time to study the adaptations of evergreen trees that make it possible for them to survive the winter and keep their leaves. Also, if evergreens aren't native, the teacher can make use of the Christmas trees that are shipped in. If possible, the children should try an experiment to find out which kind of evergreen makes the best Christmas tree. They may bring branches of spruce, fir, pine, and hemlock into the room and keep them a few days. The fir will hold its needles for a long time. The others will dry quickly and drop their needles.

If these trees are native to the region, bring cones from the different kinds and look for seeds in them. Notice the wings on the seeds and how light they are. They are easily carried by the wind. Seeds drop in the furrows or ditches along roads, and small trees spring up.

An interesting activity, where these trees are native, is to plant some of their seeds in pots or boxes and see how long it takes for them to grow. If gathered in autumn and planted indoors, they should be coming up by spring. Plant about ¼ inch deep in sandy garden soil. Other tree seeds may be planted at the same time, such as acorns, horse-chestnuts, and fruit seeds. It is interesting to watch the difference in the rate of germination. Seeds with hard shells, like nuts, should have boiling water poured over them and be allowed to stand overnight. Pine seeds may be soaked in warm water.

Fir trees not only make good Christmas trees, but have many interesting uses. The needles of the balsam fir make nice pillows. The sap from the blisters along the trunk is used to mount microscopic specimens. Children like to break the blisters with their fingernails and to smell the sticky fluid. Woodsmen use the boughs of fir trees for beds because of the soft needles. Children may feel branches of the various evergreens and decide which they would prefer for mattresses or pillows. As future Scouts and Campfire girls, this may prove useful to them, as well as interesting.

Pages: 84–85

Concepts:

Bathe each day.
Use soap and warm water to get clean.
Clean hair and fingernails are important.

Suggested Activities:

Most of us now know that keeping clean is more a social habit than one necessary to health. Also, group pressure has more effect on little girls than merely appealing to their pride. Boys aren't so easily motivated! However, the suggestions given in the Manual for THROUGH THE YEAR, page 89, to stimulate an interest in the important times to wash, may help here, also. Children must know the reasons for carrying out health activities and *want* to do them before they will form desirable habits. This involves cooperation between parents and teacher. There is little real value in making children learn rules for washing, bathing, or brushing teeth if those rules aren't applied at home. However, if children can do a few experiments at school, showing that germs are in the dirt under their fingernails, it will impress them enough to help with this problem.

The teacher may help them do a simple experiment with the growth of "germs." If the directions below are followed, a culture medium can be made, which though not completely sterile, will demonstrate that dirt contains living things which we cannot see.

Make about a quart of gelatin according to the directions on the package. Add a half pint of beef broth or a bouillon cube, a pinch of salt, and a pinch of soda.

Sterilize some test tubes or small bottles by boiling them in clean water for an hour, or putting them in a steam sterilizer for fifteen minutes, or in an oven 320°–350° F. for an hour. The flat-sided nursing bottles are good for this experiment if test tubes are not available. Close test tubes or bottles with absorbent cotton before sterilizing if an oven, pressure cooker, or steam sterilizer is used.

Pour enough of the hot gelatin mixture into each tube or bottle to fill it about one-fourth full, put cotton plugs in mouths of tubes,

and lay them on a slant to cool. When cool, there should be a slanting surface of gelatin to put the dirt on. When removing plug from tube, hold it so that the part going into the tube doesn't touch anything.

When the gelatin has cooled, it is ready to be inoculated. A stiff wire or knitting needle may be used to do this. Pass the end of the wire through the flame of a match or candle, cool, take some dirt from under a child's fingernail. Lightly run it along the surface of gelatin in a tube and again plug the tube. As many as desired may be made. They should be put into a warm, dark place, such as a cupboard or closet, for two or three days, then examined for growth of micro-organisms. Plugs should not be removed. At the end of the experiment, the bottles should be put into water, plugs and all, and boiled to kill any disease bacteria which may have grown.

It isn't necessary for children at this age to know what "germs" are in the tube. There will probably be some fuzzy looking molds and some colonies of bacteria that resemble dots of pus. Just realizing that all of these things grew from dirt under their nails should help keep fingers out of mouths, and keep nails clean.

CHRISTMAS TOYS

Pages: 86–91

Concepts:

Electricity makes some toys work.

It makes a toy train run. It makes a toy stove get hot. It makes a toy iron get hot.

It makes a toy iron get hot.

Electricity may be turned on and off with a switch.

Electricity makes lights work.

All electric things have two wires.

The electricity comes in on one wire. It goes out on the other.

A magnet will pull iron and steel things.

A knife can be made into a magnet.

Two magnets will pull each other if the ends marked "N" are not together.

Two magnets will not pull each other if the ends marked "N" are put together.

Suggested Activities:

Children's first questions on electricity very often arise when they have an electrical toy or when they help wire a Christmas tree. Even first-grade children may learn how to put a plug into a socket and take it out. They can help put the lights in the Christmas tree strings and learn that if one is missing the circuit is broken.

They should learn not to touch a switch with wet hands and that turning lights on and off is making and breaking the circuit. They may make a simple knife switch and use it in a circuit to light a small bulb. A dry cell will light one of the bulbs used in flashlights. The teacher may make a problem of this by saying, "Here are a dry cell, three pieces of electric wire, a flashlight bulb, and a switch. I wonder if anyone can put these together so that he can make the light go on and off." Since a dry cell generates only six volts, there is no danger that a child will get a shock, but the children should be taught to handle the wires by the covered (insulated) part when they are completing a circuit. If the teacher will let them help when she uses an electric plate or lantern, they will learn something about practical applications of electricity.

Although magnetism and electricity are two different forms of energy, they are closely related. Children should be allowed to experiment with magnets to find out what materials magnets will attract. They will find that iron and steel are the only common metals that magnets will attract. Magnets will attract cobalt and nickel to a slight degree but these are not familiar to children.

After the children have put in one pile all of the things a magnet attracts and in another all of those it doesn't, the children may try the experiments suggested in the story. They will discover that the magnets have two poles. Two north poles do not attract each other while the N and S poles do. Later this will contribute to the principle that like poles repel while unlike poles attract.

Review can be made of the lessons on magnets in WE SEE and THROUGH THE YEAR.

ROUND ABOUT US

Pages: 92–97

Concepts:

Air is all around us.
All animals need air to live.
There is some air in water.
Fish and tadpoles can use the air in water.
Toads and turtles cannot use the air in water.
People cannot use the air in water.
Fire needs air to burn.
The more air a fire has, the faster it burns.
Water puts out fire because it keeps out the air.
Dirt puts out fire because it keeps out the air.
If your clothing catches fire, lie down and roll in a rug or coat. This will shut out the air.

Suggested Activities:

The children should do the experiments suggested in this story. The most important reason for the story is to teach children how to put out a fire. Children should be allowed to make fires properly and to put them out under the supervision of an adult. See the Teacher's Manual for THROUGH THE YEAR, page 86, for suggestions on teaching children how to light matches and fires.

This is a good place to discuss fire prevention. In autumn, people are cleaning up yards and burning leaves. Farmers may be burning weeds. If the region has woods or forests, men are clearing out dead underbrush and trash. Discuss with the children the reasons for this. Also, discuss reasons for keeping trash and waste papers cleaned up at school and home.

A visit to the fire station is interesting to seven-year-olds, if it can be arranged; so is a visit from a local fireman, who knows how to talk to children and answer their questions. They may try the various ways suggested in the story of putting out fires.

WINTER BIRDS

Pages: 98–101

Concepts:

We should feed birds in the winter.
Birds will come to a lunch counter.

Seeds and nuts and suet are good foods for winter birds.
The goldfinch has gray feathers in winter.
Juncoes are here only in the winter.
Sparrows and horned larks eat on the ground.
Cardinals will eat sunflower seeds and apples.
The blue jay is a noisy bird.

Suggested Activities:

A section at the beginning of this Manual is devoted to bird-feeding devices. Refer to that section for help. If the children make their own, even simple trays will bring many birds. The birds mentioned in the story are all either permanent residents or winter residents in the northern part of the United States. A snowstorm will drive even the shyest birds to your window for food.

The children should learn to recognize some of the most common winter birds, and should know what foods to give them. The chickadee, nuthatch, and downy woodpecker are pictured in SUNSHINE AND RAIN. The horned lark, sparrow, cardinal, and blue jay are shown here. Refer to bird guides for the goldfinch in winter plumage and for the junco.

Bird feeding serves several purposes in the teaching of children. It brings the birds close enough to be easily watched. Nothing can afford more entertainment than the behavior of birds when they do not realize that they are being observed. This acquaintance at close range will awaken an interest and appreciation which is the first step toward teaching wild-life conservation.

Though blue jays are noisy birds and are sometimes accused of driving other birds away, they are bright and cheerful and are good parents. People who have studied them say that they are not so black as they are painted, but are merely good defenders of their nests and young. The author has seen them driven from the feeding shelf by pigmy nuthatches, many times. Any kind of swinging feeder frightens them.

STAND UP! SIT UP!

Pages: 102–103

Suggested Activities:

These pages are devoted to health concepts. The teacher can

add as much as she desires in presenting these rules of health. Perhaps the teacher and children can make additional rhymes.

FINDING ROCKS IS FUN

Pages: 104–109

Concepts:

Some rocks are harder than others.
Soft rocks break easily.
Quartz is a hard rock.
Rocks are used for many things.
They make strong houses and walls.
The Indians used quartz for arrowheads and knives.
Indians used other rocks for hammers and dishes.
Rocks are of different colors.

Suggested Activities:

Most children have the collecting instinct, and rock collecting is a good outlet for that instinct. Once started on this interest, children will swamp the sympathetic teacher with specimens and questions.

At first youngsters may separate their rocks into piles according to color, then according to hardness. They may find the difference in hardness by scratching one rock with another.

A rock may be defined as any part of the earth's crust. A mineral is a natural inorganic substance that may be expressed with a chemical formula. Probably limestone, sandstone, shale, and granite are the commonest rocks children bring to school, although the rocks would vary some in different regions. One of the commonest minerals is quartz, especially milky quartz.

Quartz is so hard that it can't be scratched with a file and it in turn will scratch glass. It breaks into curved surfaces.

To test for hardness the children should have a steel knitting needle or file. If the file won't scratch the rock they should try to scratch a piece of glass with the rock. A glass jar is good for them to use since it has no sharp edges for them to cut their fingers on. Since quartz is the only common mineral with this hardness, it is easily distinguished in this way.

Since there are many forms of quartz, the teacher will need to consult a book on rocks and minerals to help her with identifications. If arrowheads are commonly found in the region, encourage the children to bring their finds to school. Test them to determine their hardness. Arrowheads were made of all kinds of quartz including chalcedony, flint, chert, milky quartz, jasper, and even agates. Petrified wood, (wood impregnated with quartz), was used in the regions where it was plentiful. When quartz wasn't available, quartzite (metamorphosed sandstone) and hard sandstone were sometimes used. It is a fallacy that all arrowheads are flint. Flint is a form of quartz with a horny or waxy luster, usually dark gray, and is opaque except in very thin slices. If an arrowhead meets all of these characteristics, hold it up to the light. If you can see through the edges, it is probably flint.

If Indian hammerstones, skin knives, or other stone implements are found in the region, examine them and discuss the kinds of rocks which were used. That is, discuss each kind as to its hardness, its toughness, its characteristics which made it good for its purpose. For example, basalt (black rock found in the center of old volcanoes) is very tough as well as hard. It made good axes. If a basalt axe is available the boys may try to split a pine board with it for kindling.

Quartz is the only name learned in the story but if the children want to know the kinds of rocks illustrated on pages 108 and 109 they are as follows: Page 108—four kinds of quartz: rose quartz, rock crystal, flint, and jasper. The bottom picture shows granite, of which quartz is an essential constituent. Page 109—brown sandstone, gray sandstone; limestone with fossil; shale; schist.

A trip to look for uses of rocks may be taken in a locality where there are stone buildings or walls. The children should notice how the stone used in some buildings is being worn off (weathered) faster than others. Sandstone and limestone weather more rapidly than granite.

A STORY IN THE SNOW

Pages: 110–111

Concepts:

Different animals make different tracks in the snow.
Tracks in the snow often tell a story.

Suggested Activities:

This story is to suggest another way of knowing about the activities of animals in winter. Ernest Thompson Seton's books will help with tracks; also *The National Geographic Books of Mammals*. Children should go for walks after light snowfalls and look for tracks. Children may make track stories on paper and let other children try to read them.

Let a child draw some tracks across the blackboard and ask the class to tell what they are. Invite a Boy Scout from an upper grade to explain tracks to the children, and to make drawings of tracks on the board. For squirrel tracks, see SUNSHINE AND RAIN, page 81.

THE MOON
THE STARS

Pages: 112–115; 116–118

Concepts:

The moon is a heavenly body.
The moon is smaller than the sun.
There is no air around the moon.
There is air around the earth.
When the moon is round, we call it a full moon.
The moon appears to change shape.
Two stars of the Big Dipper always point to the North Star.
The North Star is part of the Little Dipper.
All stars are heavenly bodies.
People used to tell stories about the stars.
They told a story about Orion, the hunter.
Orion can be seen in the southern sky in winter.
Stars are very, very far away.
They look small because they are so far away.

Suggested Activities:

One of the most frequent questions children ask is, "What makes the moon change its shape?" Sometimes the teacher herself has trouble explaining. A good beginning activity is to go outside at a time when the moon is visible in the daytime. The children will be able to see the whole moon and that the sun is making part of it bright. Following several days of such observations, the teacher may use a light for the sun, a globe for the earth, and a small ball for the moon, to help make the phases of the moon clear. The first concept children need to get is that the whole moon is there, but seems to change shape because of its position in relation to the sun and earth. Since it shines only by reflected light and revolves counter-clockwise around the earth, it seems to change its shape.

Another activity which helps is to let each child pretend that he is the earth. As the teacher holds the ball representing the moon, the children may draw the lighted part as they see it when it is entirely lighted. As the teacher moves around the group of children, with the ball, they will see it as it appears in the different phases.

Children should begin to get the concept that the earth turns under the stars, as they watch the changing position of the Big and Little Dippers. Later in the book (page 210) a diagram shows the position of the Dippers at different seasons.

Orion is the most brilliant constellation in the winter sky. It is easily located by the three stars in the belt, which, with the stars of the sword, seem to make a kite in the sky. Children sometimes think Orion is one of the Dippers, but its position in the southern sky should clear up that point. Orion rises in the east and seems to move across the sky south of the zenith.

An interest in stars will become a permanent one if the teacher herself is enthusiastic and tries to help. Each month a star map is published in the first number of "Science News Letter." It is a simple map that children can understand. The teacher should enlarge a few of the main constellations on a chart or the board. Start with one and add to it day by day. As a child sees a constellation in the sky he may draw it on the board, and find out if he has seen one of those studied.

An effort is made in this story to give children concepts of the vastness of space and the size of the universe; also to emphasize that the earth rotates.

WEATHER IN MANY PLACES

Pages: 119–121

Concepts:

Some places are very cold in winter.
Some places are very hot in winter.
Some places are neither very cold nor very hot.
A thermometer tells how cold or hot it is.

Suggested Activities:

So far, the children have studied local weather conditions. This story gives, in an interesting way, temperature conditions in different places widely separated—Bob's own home, the mountain place where Jack lives, and the desert place near where Pablo lives. The thermometer is the instrument used in all places to tell the temperature. Keeping a record of the temperature is a real science activity. It teaches the child to record data accurately and systematically. The teacher should start an activity of keeping a temperature record of the out-of-doors weather over a period of a week or two, taking it always at the same time of day for good comparisons. This could be kept on a corner of the blackboard, on a chart made for this purpose, or in the Companion Book.

WATER IN THE AIR

Pages: 122–125

Concepts:

Heat makes water go into the air.
Cold makes water come out of the air.
Cold makes rain and dew and fog come out of the air.
When it is very cold, the water freezes and comes out of the air as snow or frost or sleet.

Suggested Activities:

In Through the Year the children performed experiments to show that water evaporates when it is heated. In this story they answer questions about what makes it rain and snow, by performing another experiment. An open pan instead of a teakettle is used to heat the water, so that the children won't see the cloud of water. With an open pan they are not able to see the water until it condenses on the cold pan. Thus they are better able to understand that water in the air is invisible. Let them feel the moist air above the open pan soon after the water starts to heat. When the children see the water dripping from the pan they often say, "Oh, it's raining."

To demonstrate the formation of frost, the pan above the water vapor may be filled with ice and salt. It should be held far enough above the other pan to prevent heating. Frost will form on the bottom and sides as the water vapor strikes the cold pan.

The Companion Book, page 44, will help to clarify the concepts given in this experiment.

CLOUDS

Pages: 126–128

Concepts:

Clouds are made of water.
Rain clouds are dark.
Some clouds are white and billowy.
Others are like feathers high in the sky.
Others, seen at the horizon, are straight.

Suggested Activities:

After evaporating water in an open pan and learning that they can't see water vapor, children can boil water in a teakettle and not think they are seeing steam. What they see is a cloud of condensed water, which is an easy way to explain cloud formation. The different types of clouds are illustrated in the pictures but not named. Rain clouds are "nimbus," feathery clouds "cirrus," rolling clouds "cumulus," and straight clouds are "stratus."

Since fog is a cloud on the ground, it may be compared to a

cloud in the sky. Both fog and clouds in the sky are formed when air filled with water vapor is chilled to below the dew point. The droplets condense around smoke or dust particles. This explains why smoky cities have more fog than does the surrounding country. Nimbus clouds, like fog, consist of water droplets. The high, feathery cirrus clouds are ice crystals. Cumulus and stratus clouds are usually water drops. Though these are the four main types, they usually occur as modified or intermediate types.

Clouds are weather indicators, so ability to recognize the forms is valuable.

Page 45 of the Companion Book may be used here.

THE WIND BLOWS

Pages: 129–130

Concepts:

Air that is moving is wind.
The wind does work.
The wind blows windmills that work for us.

Suggested Activities:

Nearly everyone knows how to make a paper windmill, but in case the method has been forgotten it will be rehearsed here. Take a square of ordinary, stiff paper, any desired size. Draw diagonals from corner to corner. Cut along these diagonals from each corner almost to the center. Stick a common pin through one of the slit corners and bend over toward the center. Take the corresponding slit corner of the three remaining corners of the square and fasten them through the pin. Then push the pin through the center of the square and fasten on the end of a stick as shown on page 129 of the book.

Review what the wind does for us in Sunshine and Rain, pages 18–19, and Through the Year, pages 58–60.

THE WEATHER VANE

Pages: 131–132

Concepts:

When the wind is very strong, there is a storm.
The wind may blow from the north, east, south, or west.
The wind is named by the direction from which it blows.
Weather vanes tell what kind of wind is blowing.

Suggested Activities:

The story explains activities that may be easily carried out by the children. Another way to tell wind direction is by fastening a bag, similar to the wind sock used at airports, to the top of a pole. Also, by wetting a finger and holding it up, one can tell from which direction the wind is coming. After a snowstorm children may try to determine the direction of the wind by the drifting snow and by snow on trees or buildings. In some regions the prevailing winds cause the tree branches to grow in the opposite direction. Encourage children to look for these effects of the wind.

Have the children keep a record for a week, showing what kind of wind blows each day.

THE EARTH

Pages: 133–134

Concepts:

The earth is round like a ball.
The earth pulls everything to it. That is why we do not fall off.
The earth does not look round to us because we can see so little of it.

Suggested Activities:

Children should try as many simple experiments as possible to demonstrate gravity. Throw a ball. Drop different kinds of objects from a window. Lift a book with an arm straight out. Try some heavier object.

The word "gravity" is not given the children in this grade. To know that the earth pulls things to it is sufficient now.

Page 46 of the Companion Book gives an interesting activity to help children understand gravity.

WHAT AM I?

Page: 135

This is an interesting review test put in rhyme form. The answers are: (1) water; (2) magnet; (3) moon; (4) air. Children enjoy making up such riddles themselves.

SUSAN'S BULBS

Pages: 136–138

Concepts:

A narcissus bulb looks like an onion.
An onion is a bulb.
A bulb has a stem in the middle.
Thick white leaves are around the stem.
Stems, leaves, and flowers grow from bulbs.
There is food in the bulb.
The growing plant gets its food from the bulb.
The bulb then becomes soft.
Plants need food to grow.
Plants need sunshine, too.

Suggested Activities:

Bulbs are like enlarged buds. In bulbs, food is stored in fleshy leaves around a little stem. By cutting a bulb in two the children are able to see what makes bulbs grow. By digging up a bulb after the flowers have bloomed the children will discover that the stored food has been used. If some bulbs are grown in soil and some in water, the children can compare the growth.

Bulbs planted in pots of dirt should be put in a cool cellar if possible and left until the roots grow. They may be brought out in winter or left until spring. If a bulb is cut open for inspection, it may be put back together again, securely tied or fastened by rubber bands, and if the growing tip is not destroyed, the bulb may grow. The artist experienced this. After he had made the drawing of a cut-open bulb, he put it back together again with rubber bands, and this bulb grew and produced flowers.

It is suggested that the material in SUNSHINE AND RAIN on the growing of bulbs be used here for pictures and for basic concepts.

In spring, the children should watch for bulbs to come up out of doors. They will see crocuses, tulips, daffodils, hyacinths, and many others.

The purpose of these pages is to add to the understanding of plants as living things. Some teachers say that children are not so interested in plants as in animals, but we believe that it is a matter of how the material is presented. Primary children have short interest spans, and plants do not move or carry on their life processes so quickly as animals. However, if quick-growing plants are used and other activities carried on while growth is taking place, children are intensely interested in plants. The teacher will have to remind the children to water the plants, to look at them from time to time, but once a sprout appears the children will be eager to watch it.

To demonstrate that growth is taking place, even though it can't be seen, the height of the flower stem may be marked on a stick, beginning when it first appears in the leaves. This growth will show up from morning to afternoon. Plants do move, by growth rather than by muscles and other structures possessed by animals.

SPRING IS HERE!

Pages: 139–141

Concepts:

In spring the birds return.
The goldfinches again have their summer feathers.
Juncoes go north in the spring.
Ants come out of their winter homes.
Bees come out of their hives.
Woodchucks come out of their holes. They are thin.
Flowers begin to bloom.
The Spring Beauty is one of our earliest wild flowers.

Suggested Activities:

Just as the children watched the seasonal effect on plant and animal life in autumn, so they should notice what happens to plants and animals in the spring. This chapter shows what happens in the spring to birds, insects, and mammals after surviving the win-

ter. The woodchuck is thin. See pages 72–73 in SUNSHINE AND RAIN for the autumn activities of the woodchuck.

The children should go for a walk to look for signs of spring. The plants and animals they see will vary in different regions. When wild flowers are seen, look at them but do not pick them unless they grow in such profusion that picking a few will do no harm. Any flowers gathered should be taken back to the room and put into water. Discourage gathering large bouquets, even of violets. Often children simply throw them away after they are picked. This is an opportunity to again teach conservation. A few flowers make a more attractive bouquet than do quantities.

A WEEK OF SPRING WEATHER

Pages: 142–143

Suggested Activities:

This chapter is put in as a guide and suggestion for keeping a record of weather. Spring weather is quite changeable so the record will show variations. The record should be made each day at the same hour for purposes of comparison. The temperature, clouds, wind, and weather are all recorded. This record will serve as a review of weather elements that have been studied during the winter. In spring there is a great variety of weather elements with many sudden changes. However, the record given follows a true weather cycle from a low-pressure area to a high.

THE APPLE TREE IN SPRING

Pages: 144–145

Concepts:

Warm spring weather makes buds on trees grow.
Buds grow on apple trees.
Some of the buds grow into pink-and-white flowers.
The flowers grow into little apples.
Some of the buds grow into leaves.

Suggested Activities:

The apple tree in spring is used as an example of the cycle of a

tree because it is so easy for children to watch the flowers open, form fruit, and ripen. Any other tree will be as good to watch, provided the flowers are easy to see. Peach, plum, or cherry trees may be observed. The children should be able to see the enlarged part of the flower, or ovary, which later contains the seed. Technically, a fruit is the ripened ovary of a flower with any parts that adhere to it. An apple is an enlarged ovary and receptacle. It is a fleshy fruit.

FROGS AND TOADS AND SALAMANDERS

Pages: 146–148

Concepts:

Toads' eggs are laid in a string.
Frogs' eggs are laid in bunches.
Tadpoles hatch from both toads' and frogs' eggs.
Frog tadpoles take longer to grow than toad tadpoles.
They grow larger.
Salamanders lay eggs in water in bunches, somewhat as frogs do.
Salamanders' eggs hatch into tadpoles.
Salamander tadpoles develop slowly.

Suggested Activities:

Amphibian eggs are easily hatched and cared for. Suggestions for their care will be found in the first part of this Manual. An important thing to remember in caring for amphibian eggs is not to let them get too warm.

To get a complete story of the life history of a toad refer to THROUGH THE YEAR, pages 76–85. The addition in this lesson is about frogs' eggs—to note the difference from toads' eggs, and also to learn that frogs take longer to develop. Salamanders are grouped here because, since they are amphibians, their eggs also hatch into tadpoles.

A comparative chart on page 48 of the Companion Book will help fix these concepts.

THE HORNED TOAD

Page: 149

Concepts:

The horned toad comes out of hibernation in the spring.
The horned toad isn't a toad; it has scales.
The horned toad does not lay eggs; its young are born alive.

Suggested Activities:

Horned lizards are interesting examples of adaptations to environment. Their grayish-brown color, rough skin, and quick motions make escape easy for them. They are harmless little creatures and may be kept alive in a terrarium. They get water by soaking it through their skins just as a real toad does. The smaller variety, so often found in the Southwest, is live-bearing. It is a reptile, not a toad. Some varieties lay eggs. This chapter is a follow-up of the chapter on pages 59–63.

THE CRAYFISH

Pages: 150–153

Concepts:

Crayfish live in water.
They dig holes in the sand.
Crayfish have pincers and strong tails.
The female crayfish fastens her eggs under her tail.
The eggs hatch into little crayfish.
Little crayfish look like their mother.

Suggested Activities:

Children often bring crayfish to school. The big pincers fascinate them, as well as the eyes that are on stalks. Children are also interested in the holes near ponds and streams that are sometimes incorrectly called snake holes. The crayfish often pile the mud around these holes until they look like little chimneys. If one digs to the bottom of one of these holes he will probably find a little pool of water in which a crayfish is hiding.

The female crayfish carries her eggs under the swimmerets on her abdomen. She usually lays them in autumn and hibernates with them fastened to her. When the little crayfish hatch, they cling to the mother's swimmerets until she frees herself by slap-

ping her tail. Newly hatched crayfish are tiny, transparent replicas of their parents. Look at one with a hand lens.

Crayfish are scavengers and will eat almost anything that is put into the aquarium, such as bread, bits of meat, or fish. After the crayfish have been studied by the children, they should be put back into the stream or pond.

Crayfish are not fish, but crustaceans. They are more closely related to insects than to fish. They do not have an internal skeleton. Their crust-like covering gives them the name crustacean.

Crayfish may be known to the children as crabs. Let them learn the correct name and use it. Crabs are broader, with the tails turned under the rest of the body. Crabs walk along on the bottom of the ocean or clamber up the rocks. They do not live in fresh water. The crayfish is a good animal to have in the aquarium in the spring, but other animals should not be put with it.

The picture on page 151 may be misleading. Crayfish do not cling to branches of trees in the air. This is Jimmy's stick which he is holding. The crayfish will soon drop off.

Page 49 of the Companion Book gives a good review of the concepts given in this story.

WIGGLERS

Pages: 154–157

Concepts:

Mosquitoes lay eggs on water.
Wigglers hatch from the eggs.
Wigglers live in water.
Wigglers must have air.
Wigglers grow into mosquitoes.
If we can kill wigglers, we will kill mosquitoes.
Oil on water kills wigglers because it shuts out the air.
Fish eat wigglers.

Suggested Activities:

The teacher should bring in some stagnant water with wigglers in it and let the children watch their development. The container should be kept covered so that the adult mosquitoes won't escape.

The larva stage of the mosquito is called the wiggler. In this stage it lives in the water and feeds on microscopic organisms. It breathes air from the surface through a breathing tube at the tip of the abdomen. Thus, putting oil on the water when the mosquitoes are in the larval stage, kills them. If the wigglers are in a lake or pool containing other animals and plants, oil will kill the other living things. A better way to kill them is to put into the pond fish or tadpoles that will eat the wigglers. The experiments suggested in the story will demonstrate this.

Through discussion bring out the fact that some mosquitoes carry germs. This is another reason for killing them.

THE INSECTS IN SPRING

Pages: 158–159

Concepts:

The caterpillar in the goldenrod gall hatches into a moth.
The moth comes out of a tiny hole in the gall.
The caterpillar made the hole.
Different insects make different kinds of galls.

Suggested Activities:

This story follows up the activities done in autumn and completes the cycle of the insect's life. As far as possible the teacher should try to supply material similar to that suggested in the stories so that the children can watch the insects they are reading about.

There are many kinds of gall insects that lay their eggs on different plants. One of the commonest galls is the oak apple, illustrated on page 159. The other galls illustrated on this page are the spiny rose gall and the oakbullet gall.

THE BUTTERFLY

Pages: 160–162

Concepts:

A butterfly comes out of the chrysalis made by the carrot caterpillar.

It has black wings with yellow and blue spots.
It is a black swallowtail butterfly.
Swallowtail butterflies have tails on their wings.

Suggested Activities:

The swallowtail butterflies are common all over the United States. The black swallowtail is used because the "carrot worm" is so common, but the life histories of all swallowtails are similar. The larva of the black swallowtail feeds on any plant belonging to the carrot family, such as parsley and dill.

This chapter is a continuation and conclusion of the finding of the carrot caterpillar in the autumn (pages 12 and 22). The teacher should try to give children as many experiences with caterpillars, butterflies, and moths as possible.

Suggestions for rearing caterpillars will be found in an earlier section of this Manual.

THE MOTH

Pages: 163–169

Concepts:

A moth comes out of a cocoon.
A butterfly comes out of a chrysalis.
A Cecropia moth emerges from the cocoon made by the green caterpillar.
Moths have fat, fuzzy bodies.
Butterflies have thin bodies.
Feelers on a male moth are larger than on a female.
Male and female moths mate.
The female lays eggs.
The eggs hatch into caterpillars.
Young Cecropias shed their skins four times.

Suggested Activities:

The Cecropia moth is one of our most beautiful moths. The larvae feed upon a variety of common trees such as apple, plum, and pear. They may be fed on lilac leaves. Suggestions for rear-

ing caterpillars will be found in the first part of the Manual. Cecropia caterpillars seem to be more susceptible to bacterial infections than do smooth caterpillars. The tubercles on their bodies are easily bruised, so care must be used in handling them. Instead of picking them up, let them crawl onto the fresh food.

Children should look at moths and butterflies and observe the differences in them before reading about them. In all cases with the teaching of science in the primary grades, observation should come first; reading, second. Children learn best those things they feel a desire to know.

If Cecropia moths are not found in your region, any moth that spins a cocoon will demonstrate the life history of a moth. The differences the children notice will only help to build up their scientific attitudes. They will learn that variation is a law of nature. Io moths, Luna moths, Prometheus moths, Polyphemus moths, and Imperial moths are all closely related to the Cecropias.

LITTLE SPIDERS

Pages: 170–171

Concepts:

Spider eggs do not hatch into caterpillars.
Spider eggs hatch into little spiders (spiderlings).
Little spiders spin webs.
Spiders catch food in their webs.

Suggested Activities:

Children frequently find the egg cases of spiders and mistake them for cocoons. At a time when they are learning about insect life histories they may also be keeping spider-egg cases and discovering that spiders do not have a metamorphosis. They will also find out that spiders are not insects, but that they destroy insects.

If spiders have been kept in a terrarium until they made egg cases, the terrarium will be full of spiderlings. One egg case may be kept for observation and the others put outside.

This chapter is a continuation and conclusion to pages 26–28 in WINTER COMES AND GOES.

CAN YOU FIND IT?

Pages: 172–173

It is the purpose of the animal stories to lay a foundation of concepts of the characteristics of animal groups. In the first books of The How and Why Science Series the children found out that insects, fish, amphibians, reptiles, birds, and mammals were all animals. Now they are learning things about these animals that differentiate them.

The teacher's job is to have materials to help the children gain these concepts. First they should differentiate between living and non-living things. Living things feed; non-living things do not. Living things breathe; non-living things do not. Living things grow; non-living things do not. Living things produce new living things like themselves. A dog and a rock could be compared to show differences.

Next they need to differentiate between animals and plants. Compare a tree and a rabbit. Of course, there are plants and animals so similar that even scientists disagree about them, but there is no need to confuse children by mentioning these. The plants and animals familiar to the children are the ones to start with. Later the children can enlarge their concepts to include lower forms.

Pages 172 and 173 are test question pages to bring out recognition of various animals studied so far. The answers to the questions are: (1) Cecropia moth; (2) horned toad; (3) black swallowtail butterfly; (4) fish; (5) crayfish (page 172); (6) bird; (7) spider; (8) mosquito (page 172); (9) green caterpillar; (10) tadpole.

HOW DO SEEDS GROW?

Pages: 174–177

Concepts:

Water helps make seeds grow.
Beans will grow if planted in moist sand.
Food stored in the seeds helps them grow.

Plants will not grow without water.
Sunshine helps plants grow.

Suggested Activities:

Little children are interested in action. Seeds that sprout quickly and are large enough for the children to see easily interest them most.

Preceding these stories the children should sprout some seeds so that they may do the experiments suggested. They should review the fact that seeds have food stored in them to supply nourishment until the new plant is above the ground and able to make its own food.

The teacher should encourage the children to set up experiments of their own. They may want to do others in addition to those in the story. Some child may wish to sprout some seeds without water. Let him try it.

In setting up the experiments to show necessity for water and sunshine for a growing plant, be sure to have the control set up, also. That is, have the same kind of plant, growing normally, with both sunshine and water.

Review the lessons on the bean cycle in WE SEE, pages 46–48, and THROUGH THE YEAR, pages 100–105.

The children may record their results on page 54 of the Companion Book.

THE SUN HELPS US

Pages: 178–179

Science Concept:

Plants grow toward the sun.

Health Concepts:

Sunshine is good for us.
Sunburns are not good for us.
Sunshine helps us grow.
Sunshine helps animals grow.
Sunshine helps plants grow.

Suggested Activities:

Another experiment to show the need for sunshine is to put one plant in a dark box that has a single small hole in it. The plant will grow toward the hole and may even grow out of it.

In all the experiments showing how plants need sunshine, the teacher should be sure the children understand that the plant grows toward the light. It doesn't turn the way an animal turns. When leaves turn toward light the cells on one side of the stems grow faster than on the other side, thus making the leaves turn; of course children can't understand this, but they can understand growth. No experiment that the children perform should be done with just one example. Several plants of the same kind and of several different kinds should be used in each case.

SOME NEW SEEDS

Pages: 180–181

Concepts:

Not all seeds are the same.
Different seeds grow into different plants.

Suggested Activities:

Nasturtium seeds are quite large and can be handled easily by the children. The seeds may be purchased in 5¢ and 10¢ packages. They can be grown in the house and if started in the fall, will bloom all winter.

Show the children how to plant the seeds, cover them with earth, and water them every day. This is an individual activity with each child having a flower pot with two seeds planted in it. As the seeds sprout and grow, the stages of growth as shown in the pictures on pages 180 and 181 may be observed.

Paper cups or cans may be used if pottery pots are not available. The children may take their plants home and transplant them to the garden, after observing their growth.

WILD FLOWERS

Pages: 182–185

Concepts:

Wild flowers are flowers which no one plants.
Some wild flowers should never be picked.
Flowers make seeds.
If we pick flowers there will be no seeds to make new plants.
Violet roots live all winter.
We may pick some violets.
Wild flowers should be picked by their stems, not pulled up by their roots.

Suggested Activities:

The purpose of wild-flower study should be to develop appreciation and a desire to protect them. It is natural for people to want to pick flowers when they see them. Some wild flowers grow in such profusion as to make them weeds. These may be picked without danger of extinction. Sunflowers, asters, black-eyed susans, Queen Anne's lace, and dandelions are all examples of these. To children these make just as nice bouquets as the rare wild flowers. Since violets do not depend upon their flowers for reproduction, they too may be picked in moderation.

The teacher should send to the Wild Flower Preservation Society for a list of those flowers that should never be picked. If there is a suitable spot on the school grounds a wild-flower garden may be planted. Seeds may be bought from seed companies. If there are woods with big patches of wild flowers near the school a few may be carefully transplanted.

Any wild flowers that are picked should be placed in water and not allowed to wilt. Education should eventually eliminate the careless campers who break boughs of trees, strew the ground with wilted flowers, and otherwise destroy wild life.

Columbine and Indian paint brush, illustrated on page 184, are mountain wild flowers. The desert cactus is illustrated on page 185. The children should learn that the thick green part of the cactus plant is the stem, and that the sharp spines are the leaves. In regions where cacti grow, it is interesting to compare the shapes of the queer stems. Discuss the way the structure of the plant protects it from drying out in the dry place where it lives. A cactus plant has been known to bud, grow, and bloom standing on a shelf without soil.

Pages: 186–191

Concepts:

Young animals can be cared for indoors.
They should be kept warm.
They should be given warm milk when they are very small.
As their teeth grow, they should be given other food.

Suggested Activities:

The story of Peter and Pan as given in this book is a true story with the exception that the squirrels were reared in school by a second grade under the guidance of the teacher. Almost every spring some orphaned mammals are brought to school. Although some are lucky enough to be found, many die after storms. This story is intended to arouse an interest in such little creatures and a sympathetic attitude toward animals. Often a child who may have cruel tendencies grows more gentle as he helps care for a helpless rabbit or squirrel.

All young mammals drink milk until their teeth are large enough to eat other food. The milk should be diluted with warm water. Condensed milk is more easily digested than raw milk, since the fat globules are broken down. The dilution of the milk and the amount it will eat depends upon the size of the animal. Red or fox squirrels are more easily reared than the cottontail rabbits. They should be kept in a warm, dry box with something they can hide under. A bottle of warm water wrapped in a piece of flannel and put into the box will guard against chilling on cold nights. Cleanliness in their care is important.

A drop or so of cod-liver oil a day is good for these little mammals. Too much may kill them. The less they are handled, the better for the animals, but the value derived by the children by being allowed to hold them outweighs the loss. Of course, the youngsters should be encouraged to handle them carefully. After all, our aim is to develop desirable habits in children. It is natural for children to want to touch the little animals and by doing so they satisfy their curiosity. Left unsatisfied they might later chase, torture, or wantonly kill animals for no good reason. Being

allowed to feed and care for a helpless young animal will do more for the ethical development of a child than all the lectures we may give.

Since we also want to teach conservation, we do not encourage bringing to school any young animal which is out of the nest. When a young squirrel is out of the nest, the chances are good that it can go back. Only when it is certain that birds or mammals are left motherless, should we pick them up and care for them.

EASTER PETS

Pages: 192–198

Concepts:

Feathers on little ducks and little chickens are called "down."
Ducks are water birds.
Chickens are land birds.
Webbed feet help ducks to swim.
Sharp claws of chickens help them to dig in the ground.
Ducks have flat beaks.
Chickens have sharp beaks.
Both ducks and chickens come from eggs.
Duck eggs are larger than chicken eggs.

Suggested Activities:

Here is a pet belonging to the class of birds instead of mammals. Through a study of its characteristics, the children can learn characteristics of birds in general. Ducks belong to the group of water birds. Chickens are land birds. Ducks are swimmers. Chickens are scratchers. Both ducks and chickens may be kept for a while at school and compared. In fact, a hen may incubate the eggs of either ducks or chickens, at school. The children should see both ducks and chickens and compare their feet, beaks, and shapes of their bodies.

In THROUGH THE YEAR is an activity in which children get a setting hen and hatch some little chickens. A hen will incubate little ducks, also. Refer to the story in THROUGH THE YEAR, pages 12–21.

A nest box should be made for setting a hen, and fastened to the outside of the window. It should be placed so that the window

may be closed, allowing the children to look at the hen through the glass, or opened when the hen needs exercise and food. Straw may be placed at one end of the box and a pan of water and food at the other end. Having the box outside of the window keeps it ventilated and prevents unpleasant odors in the room.

Duck eggs require four weeks for incubation. After they have hatched, it is interesting to put a large pan of water on the floor near the ducks. Their behavior seems to puzzle and distress a hen but it is both amusing and instructive to children.

A pen with legs, like a baby's play pen with wire sides, is a good place to keep either ducks or chickens. Put straw, sawdust, sand, or newspaper on the floor and a box at one end for them to sleep in. At first they may be kept warm with a light bulb in the top of the box or a glass jar of hot water. Wrap the jar in cloth so it won't burn the ducklings. Of course, if the hen is with them, she will furnish the heat.

A sand table may be used if one is available. Put a strip of chicken wire around it to keep the ducklings from jumping out.

This type of activity develops an attitude of protecting wild life because it satisfies the children's curiosity, gives them the opportunity to handle live birds, and develops appreciation of them.

THE EARTHWORM

Pages: 199–200

Concepts:

An earthworm has bristles on its underside that help it crawl.
Earthworms live in holes in the ground.
Earthworms help make the soil better for plants.

Suggested Activities:

An easy way to keep earthworms for observation is to put them into a crock of garden soil. A layer of light-colored sand on the surface of the soil will make more evident the little piles of subsoil that the worms bring to the surface. If bits of lettuce are put on the sand and a piece of cardboard used to cover the crock, the earthworms will come to the surface to eat.

By studying earthworms the children learn how useful they are to the farmer. They also learn enough about their structure to realize that even a simple animal has certain modifications which help it to live where it does.

Earthworms breathe through their skins, which must be kept moist for air to pass through. If earthworms can't dig into moist soil, they will dry out and die.

Page 59 of the Companion Book may be used to record observations.

THE ORIOLE NEST

Pages: 201–205

Concepts:

The male oriole is very bright in color.
The female is dull in color.
The female oriole makes the nest; the male does not help.
The nest is made of milkweed strings.
The female weaves the strings into a nest.
The male oriole sits by and sings.
The female sits on the six little white eggs with black and brown lines on them.
Young orioles hatch in two weeks.
Young orioles eat caterpillars; they eat hundreds of them.
When the young are grown and have feathers, they fly away.

Suggested Activities:

This story is about the Baltimore oriole, but its habits are very similar to the habits of any oriole. The Bullocks oriole of the West builds a larger nest than the Baltimore. The orchard oriole of the South and Middle West makes a nest of grass. All orioles are good weavers and have interesting life histories.

Nest-building activities of birds are very interesting. There is value in the day-by-day observation of one pair of birds. Scientists make accurate records when they are studying animal habits. Children may begin to develop the scientific method of study in this way.

They will also have more appreciation of the value of birds as

insect eaters when they have seen parent birds bring caterpillars and other insects to their young.

The use of *baby* in speaking of the young of animals other than human beings, is not scientifically correct. It is a common usage, however, and is used in this story. Young birds are properly known as fledglings, but because of vocabulary difficulty the word is not used in this book.

It is also a common practice to assign human characteristics to lower animals. It is very easy to do this, especially with birds. Their behavior *seems* to be so much like that of people that it is hard to realize that there is no conscious planning back of it. As long as children realize that this is not true, bird study is probably more interesting when the birds are endowed with personality. But *never* should the teacher forget that lower animals do not reason, anticipate, or make conscious preparations; they act only by instinct. Instinct is wonderful enough in itself to fascinate children.

PETS ON THE RANCH

Pages: 206–207

Concepts:

Lambs that are not cared for by their mothers are called "bum" lambs.

Bum lambs drink milk from bottles.

Suggested Activities:

This story takes us to a mountain or prairie environment where lambs are raised in great numbers. Sometimes a mother sheep will disown her own lamb and leave it. Sometimes the mother sheep dies. If the lamb is not cared for, it dies. So Jack has the job of caring for the bum lambs. It would be well if the class could visit a farm or ranch where there are lambs in the spring. The picture (page 207) shows how bum lambs are fed on the ranch where there are many of them to care for.

Someone may have a pet lamb which may be brought to school for a day.

THE SPRING SKY

Pages: 208–210

Concepts:

We see Orion only in the winter.
The Milky Way is composed of many, many stars very far away.
The Big Dipper is upside down in the spring.
The Big Dipper seems to turn around in the sky.
It seems to turn around the North Star.

Suggested Activities:

This story is to continue the study of the sky that was started during the winter term. The spring sky is much different from the winter sky studied on pages 116–118. One notable change is that the Big Dipper is in another position. The children will probably observe that the position of the North Star remains unchanged and that the Big Dipper seems to revolve around it. The illustration on page 210 will be helpful in showing the different positions of the Big Dipper at different seasons. Notice that the story says the Dipper "seems" to turn about the North Star. Actually, of course, the position of the stars does not change in relation to our solar system. It is the position of the earth which changes. The children will begin to get this idea as they continue in their study of the sky. Let the children draw pictures of the constellations with which they are familiar.

HOW TO EAT

Page: 211

Health Concepts:

Wash your hands before you eat.
Milk makes you strong.
Vegetables are good for you.
You should drink water every day.

Suggested Activities:

This page is given to teaching health concepts through some rhymes. The teacher may add whatever she likes to this page. The children may want to work out other rhymes.

THE DAISY MARY

Pages: 212–215

Concepts:

Boats float.
Wind makes sailboats go.
Two children can balance each other on a seesaw.
A seesaw that does not balance will not go.

Suggested Activities:

Physical science does not come into the young child's experience as much as biological science. The teacher has to be more alert to find examples for physical science teaching.

There are many common machines that are built upon principles simple enough for children to understand. Children may experiment at school to find out why boats float. By trying to float a piece of tin and a tin pan they discover that things heavier than water sink unless they contain air.

They may learn that wind is one force that may be used to move things.

A seesaw is a lever that does no work when it is not balanced. But if the two children on one end move nearer the center they will find out that one child can balance them. If one child wishes to raise a weight heavier than himself he must increase the distance between himself and the center of the seesaw, or decrease the distance between the weight and the center.

The children may try out the principle of the lever in the schoolroom. Make a seesaw by balancing a small strip of wood on a cork or other object. Put various things on the ends, such as a bottle of paste on one end and an eraser on the other. By moving one of them, make them balance. Also, try putting two objects on one end.

WHEELS

Pages: 216–217

Concepts:

People once had to carry loads on their backs.
Someone thought of pulling the load on a sled.

Someone else thought of putting rollers under the sled.
Finally someone thought of wheels.
Wheels make the hauling of loads much easier.

Suggested Activities:

These pages should help answer some of the questions children ask about wagons, sleds, and other toys. We do not intend to teach physical principles in the second grade, but we can introduce concepts which are useful as well as basic to a later understanding of principles. A wheel is actually a series of levers. As it turns, the end of each spoke becomes a fulcrum as it is down. At second-grade level, we simply want children to realize that wheels save work and to appreciate the stages in their development.

The children should carry out the activities suggested in the text to get the feel of the decreased pull on their hands. If a spring scale is available, it may be used to measure the difference in force needed to move the box of rocks without rollers, with rollers, and with wheels. Cylindrical pencils may be used for rollers.

A DRY COUNTRY
WATER FOR THE DRY COUNTRY

Pages: 218–221

Concepts:

Very little rain falls in the dry country.
Water must be used carefully.
Farmers know how to water the fields without rain.
They store water in big lakes.
They make ditches in their fields.
They let the water run from the lakes to the ditches.
The water makes the fields wet.
When the fields are wet, the seeds will grow.
Dust storms often come in dry countries.

Suggested Activities:

These last two stories are to teach the importance of water and how it may be conserved. People who live where water is plentiful sometimes do not realize how necessary water is to their daily

lives. Conversely people who live where water is scarce do not realize what floods may mean. The concepts developed in these stories should help teach water and soil conservation.

The teacher may obtain much teaching material on soil conservation from the Soil Conservation Service, Albuquerque, New Mexico and also from the U. S. Department of Agriculture at Washington, D. C.

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A KEY TO THE COMPANION BOOK

Page 1—Read suggestions in Manual on how to plan and lead a group of children on a field trip.

Page 2—Answers to riddles:

1. Monarch butterfly
2. bee
3. milkweed (Monarch) caterpillar
4. grasshopper
5. carrot (Black Swallowtail) caterpillar
6. green (Cecropia) caterpillar
7. ant
8. spider
9. goldenrod

Page 3—The first caterpillar is the milkweed caterpillar. For its colors, see page 8 of WINTER COMES AND GOES. The second one is the Cecropia caterpillar, see page 13. The third is the carrot caterpillar, see page 12. The Cecropia caterpillar spins a cocoon and becomes a moth. The other two caterpillars make chrysalids and become butterflies.

Page 4—Galls are growths of plant tissue stimulated by the larva of some insect. The ones shown in the picture are:

1. elm leaf gall
2. enlarged interior of elm leaf gall showing insects
3. oak bullet or oak-nut gall
4. blackberry cane gall
5. spiny rose gall
6. oak knot gall
7. interior of oak knot gall

Page 5—The pictures at the top of the page are of the milkweed caterpillar. For the children's pictures, see page 21 of WINTER COMES AND GOES and pages 56 and 57 of SUNSHINE AND RAIN.

Page 6—Picture is of the big green (Cecropia) caterpillar. It makes a cocoon. A moth comes out in the spring. The

last exercise on this page is to review the other green caterpillar the children found in the first grade. It was a Polyphemus moth.

Page 7—*First Column*:

1. Milkweed larva
2. Polyphemus cocoon, with moth emerging
3. Milkweed chrysalis
4. Milkweed caterpillar ready to form chrysalis

Second Column:

5. Polyphemus moth
6. Moth caterpillar spinning cocoon
7. Adult butterfly (Monarch)
8. Moth caterpillar

Pictures 8, 6, 2, 5 are the moth; 1, 4, 3, 7 the butterfly.

Page 8—See Teacher's Manual for suggestions for making an aquarium.

Page 9—The fish and tadpole are alike in that they:

breathe under water
eat water plants
are animals
grow

Since true tails have bones, tadpoles do not have *true* tails but the children are too young to understand this.

They are not alike in that:

the fish does not come out on land
the tadpole does not have pretty colors
the tadpole does not swim with fins
the fish does not have a smooth skin but has scales
the fish has fins
the tadpole grows legs

Page 10—The roots get water for the tree.
The trunk carries water to the leaves.
The leaves make food for the tree.
The branches hold up the leaves.
The twigs have flowers on them.

Correct words at bottom of page are:
soil water soil food.

Page 11—Things made from trees:

fence house table chair newspaper wood box

Things grown on trees:

apple pear oranges cherry

Page 12—The children are supposed to draw in the space beside

the pictures, places where the seeds might logically be dropped. Examples:

Dog might drop burrs in the yard, where he lies and scratches.

Bird might eat the berries and the seeds be dropped under a tree where it perches.

Squirrel might bury nut in a lawn.

Water might wash seeds into a little bay.

Wind might carry seeds to a garden.

Page 13—The roots on the page that are eaten are:

sweet potato	carrot
turnip	parsnip
beet	radish

Page 14—The children should read the riddles and decide on the birds before cutting out the puzzles on the opposite page. The birds described are:

goldfinch robin downy woodpecker nuthatch

Page 15—If each puzzle is cut and assembled separately, it will not be mixed up.

Page 17—The oriole would make its nest on the end of the hanging branch.

The hen—on the ground.

The robin—in the crotch.

Page 18—The animals which hibernate are:

woodchuck snake turtle frog salamander

The woodchuck in the burrow in the ground.

Snake—under a rock.

Turtle—in mud in pond.

Frog—in mud of pond.

Salamander—under a log or rock.

Page 19—Discussion.

Page 20—Plants in first picture are cactus and palm trees. In second picture, trees, bushes, and other plants typical of a moist region.

Page 21—The pictures connected with the fish by lines would be: bass, goldfish, swordfish, eel.

To cow: donkey, kitten, skunk, racoon, opossum.

To bluejay: penguin, duck, goldfinch, turkey.

To turtle: alligator, lizard, horned toad, snake, painted turtle.

To frog: toad, leopard frog, salamander, tadpole.

Page 22—The animals with gnawing teeth are:
woodchuck, chipmunk, squirrel, rat, prairie dog.

The ones with tearing teeth are:
tiger, bear, skunk, wolf, fox.

Page 23—Children's drawings.

Page 24—There will be lines between the first part and all groups of words but
rocks on which the sun is shining
dry walks on which the sun is shining

Page 25—Snowflakes are alike in that they all have six sides or points.

They are unlike in that they have different designs.

Frost is like snow in that it is made up of ice crystals.

Be sure that any snowflakes the children cut or draw have six points.

Page 26—Picture of Eskimo: line as short as possible.

Picture of Rita and Pablo: line as long as possible.

Picture of boy in snow: line around freezing.

Picture of schoolroom: line near 70°.

Picture of woods and river: near 80°.

Picture of woods in autumn: near 50°.

Page 27—By "things that go with each day" is meant something associated with the kind of weather, like raincoats with fog, overshoes with snow.

Page 28—Salt dissolves; flour does not dissolve; dirt does not dissolve. The colors have nothing to do with the way the water will look. They are used merely as a means of indicating what happens.

Page 29—The water evaporated, leaving salt crystals on the sides and bottom of the glass. These may build up large "hopper" shaped crystals, so called because they are shaped like grainhoppers. They consist of cubes stacked in such a way as to appear in the hopper shape.

Page 30—In the first picture the children should show water trickling down through the earth. In the second one,

show it making a little hole in the rock layers. In the third picture they should show just the cave in the rocks. Let them use their own ideas.

Page 31—The sentences which should go under the evergreen tree are:

numbers 1, 4, 6, 7, 10, 11.

Page 32—A cow and a tree are alike in that they:

are alive, grow, breathe, need food.

Page 33—The picture at the top of the page is a cross section showing some of the living and non-living things which have been discussed.

Things listed that are not alive:

salt crystals	cloud	air	shells
airplane	cave	water	snowflakes
rainbow	rocks	dew	nest
	sand	fog	

Page 34—The second switch is making the light go on.

In the bottom picture one wire must go to the copper pieces into which the switch fits when it is closed. Otherwise, the circuit is not completed.

Page 35—From left to right, the things are moved by:

engine, electricity, water, magnet, is alive, wind.

Page 36—The ones which come to the top to breathe are:

snail, boy, duck, snake, turtle, toad, frog.

Page 37—The correct words are:

1. swim
2. fish
3. clean
4. they cannot get enough water
5. the trees stop growing
6. seeds
7. a smooth skin
8. hide
9. hibernates
10. how warm it is
11. very cold
12. dissolve
13. seeds
14. evergreen
15. a magnet
16. different

Page 38—Any winter birds, such as juncoes, cardinals, sparrow, blue jays or nuthatches.

Page 39—The birds couldn't eat the nuts because they were not cracked.

Page 40—The things in the picture are a glass jar and a steel file.

See Teacher's Manual for further information on testing rocks.

Page 41—Woodchuck tracks wouldn't be seen in winter but they are included as an animal the children have discussed and one whose tracks might be seen in mud at other seasons.

Page 42—The sun is in the east in the morning.
The crescent moon is in the west.
The Big Dipper is in the north.
Orion is in the south or southwest in winter.

Page 43—Answers are:

1. goes down
2. insects
3. seeds
4. ice
5. six
6. fireman
7. roll up in something
8. summer
9. juncoes
10. sun shines on it
11. away from you
12. always
13. hard
14. air
15. doing things
16. far away

Page 44—Lines between:
stove—sun
water dripping—rain
space between saucepan and water in other pan—water in the air
water in pan—water in ponds and rivers

Page 45—Children may use chalk and crayons to make the clouds.

Page 46—The leaves, ball, boy, and water would go to the top of the page. Without gravity, everything would fly off the earth.

Page 47—Seeds: peanut, bean, walnut.
Bulbs: tulip, narcissus.
Buds: rose, apple, cherry, pussy willow.
Roots: turnips, carrots, sweet potato, root of dandelion.

Page 48—Salamanders, frogs, and toads have smooth *skins.* All of them lay *eggs.* The eggs hatch into *tadpoles.* The tadpoles breathe like *fish.* The *salamander* keeps its tail when it grows up. The toad is very young when it gets its *legs.* The toad comes out of the *water* when

it gets its legs. The frog takes longer to get its *legs* than the toad does. Frogs and *toads* have strong legs. Frogs and toads can *jump* a long way. Frogs' feet are something like ducks' feet and help frogs to *swim.* Salamanders, frogs, and toads eat *insects* that would eat plants in the garden.

Page 49—1. crayfish
2. crayfish has more than six legs
3. eggs under abdomen
4. little crayfish hanging on mother's tail
5. little crayfish swimming

Page 50—1. Children should draw the things that they find in their pond water.
2. They may see other water insect larvae or tiny worms in the water. With hand lenses or reading glasses they can see the differences. It isn't important that they *know* what all of the animals are, just that they realize that many insects, especially mosquitoes, live in water.
3. Any stagnant water will usually have mosquito larvae in it.
4. The oil will kill the wigglers. Any oil may be used, vegetable oil will do. Kerosene is usually used.

Page 51—1. Fish
2. Toad
3. Crayfish
4. Spider
5. Mosquito pupa
6. Horned toad
7. Salamander

Page 52—1. The male moth has much larger antennae.
2. The larva and cocoon at the right are of the Cecropia moth.

Page 53—See text, pages 168–169.

Page 54—Although the experiment is similar to the one described on pages 174–179 of WINTER COMES AND GOES, the children may not have the same results. Be sure that they record what happens to *their* plants, not what happened

in the story. Discuss possible reasons for the differences. If the results are the same as those in the story, the words in the blanks will be:

sun, yellow, lived, died, grew, sun, grow, grow, die

Page 55—The flowers shown are:

1. thistle, aster, goldenrod 2. calla lily, rose
3. cactus 4. water lilies
5. paintbrush, columbine

Page 56—1. soil 2. water 3. air
4. soil 5. stones 6. turning
7. plants 8. sunshine 9. air

Page 57—1. watch it 5. let it go
2. kill it 6. kill it
3. put it out of doors 7. let it spin a web
4. watch it 8. let it go

Page 58—Robin: a perching bird and also a song bird. It lives in the trees.

Chicken: a scratching bird, does not fly well. Has heavy legs and feet fitted for getting food from the ground. Beak fitted for picking up food.

Duck: a swimming bird with webbed feet. Beak fitted for getting food from the water. Body shaped something like a boat.

Perching birds: Oriole, blue jay, bluebird.

Scratching birds: Turkey, quail, pheasant.

Swimming birds: Mallard duck, gosling, swan, Canada goose.

Page 59—Let the children fill blanks with their own observations.

Page 60— I. 1. oriole 3. robin 5. hen 6. duck

II. 1. oriole
2. oriole
3. duck
4. goldfinch
5. hen
6. robin

Page 61—The North Star is at the end of the handle of the Little Dipper. Sirius, the dog star, is to the left and below Orion.

Page 62 his page.

yon may

ne scales.

umber of

that the

Page 63 nces.

Page 64

country

glass jar

Page 62—The children should do the experiments on this page. A chalk box is a good size to use. Colored crayon may be used to draw the length of the pointer on the scales. It isn't important to be exact and mark the number of pounds or ounces. The important concept is that the pull is less for 3 than 2 and still less for 4.

5. (1) heavy things are
   (2) are hard to pull
   (3) rollers
   (4) wheels
   (5) do work

Page 63—Let the children draw from their own experiences.

Page 64—Correct answers:

1. glass jars
2. count its legs
3. horned toads do not live in that part of the country
4. seeds
5. dissolve
6. crystals of rock
7. go out
8. the female will lay eggs in it
9. thin clothes
10. dig up part of the ant hill and put it into a glass jar

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